JEE-Main-16-03-2021-Shift-1 (Memory Based)

PHYSICS

Question: Heat and Work are:
Options:
(a) Extensive variables
(b) Intensive variables
(c) Path functions
(d) Point functions
Answer: (c)
Solution:
Heat and work both path function. Heat and work depend on the path taken to reach the final state from initial state.

Question: On what factor stopping potential depends for photoelectric effect?
Options:
(a) Amplitude of light wave
(b) Frequency of incident photon
(c) Initial phase
(d) Speed of light
Answer: (b)
Solution:
According to Einstein's photoelectric equation:

$$hv - hv_0 = eV$$

Where v incident frequency, v_0 threshold frequency and V stopping potential

$$V = \frac{h}{e}v - \frac{h}{e}v_0$$

So, it is clear from the equation that the stopping potential depend on incident frequency (v)

Question: A dielectric slab (dielectric constant K) of thickness $\frac{3d}{4}$ is introduced in a capacitor of capacitance C of plate separation d. The final capacitance will be:
Options:
(a) $\frac{4}{3}(K+3)C$
(b) $\frac{4KC}{K+3}$
(c) $\frac{KC}{K+3}$
(d) $\frac{3KC}{K+3}$

Answer: (b)
Solution:

$$C = \frac{\varepsilon_0 A}{d}$$

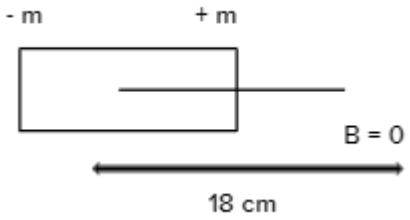
And for dielectric slab we have formula:

$$C' = \frac{\varepsilon_0 A}{\left(d - t + \frac{t}{K}\right)}$$

So, as per question:

$$C' = \frac{\varepsilon_0 A}{\left(d - \frac{3d}{4} + \frac{3d}{4K}\right)} = \frac{4K\varepsilon_0 A}{(3+K)d} = \frac{4KC}{(3+K)}$$

Question: A bar magnet is of length 14 cm and is kept in a magnetic field of 0.4 Gauss. Net magnetic field at a distinct of 18 cm from centre of magnet is 0. See the figure find the magnetic moment in SI units.



Options:
(a) 0.7
(b) 0.5
(c) 0.84
(d) 0.98
Answer: (c)
Solution:

Magnetic field at a point on axial line, of Bar magnet of length $(2l)$ and magnetic moment (m) is:

$$B_{axial} = \frac{\mu_0}{4\pi}\frac{2mx}{\left(x^2 - l^2\right)^2} \text{ (magnitude)}$$

Where *x* is distance of point from centre of magnet.

So as per question:

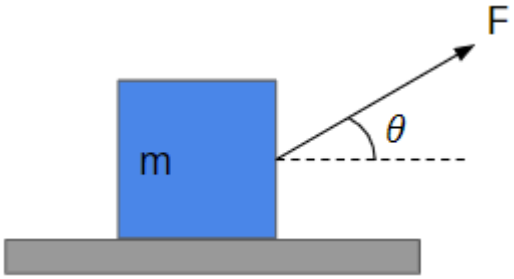
Net magnetic field is zero at a point, 18 cm from centre of bar magnet on axial line, when placed in a magnetic field of 0.4 Gauss. So, external magnetic field must be equal in magnitude, and opposite in direction to the magnetic field due to bar magnet at that point, So:
$\left(1 Gauss = 10^{-4} T\right)$

$$\Rightarrow \frac{\mu_0}{4\pi}\frac{2mx}{\left(x^2-l^2\right)^2}=\left(0.4\times10^{-4}\right)$$

$$\Rightarrow 10^{-7}\frac{2m(18\times10^{-2})}{\left((18)^2-(7)^2\right)^2\times10^{-8}}=\left(4\times10^{-5}\right)$$

$\Rightarrow$ Solving this we get $m=0.84$ A m²

Question: A constant force F is applied on a block at an angle θ with horizontal, as shown in figure. The coefficient of friction is given to be μ. Find the acceleration of the block.



Options:

(a) $\frac{F}{m}(\cos\theta+\mu\sin\theta)-\mu g$

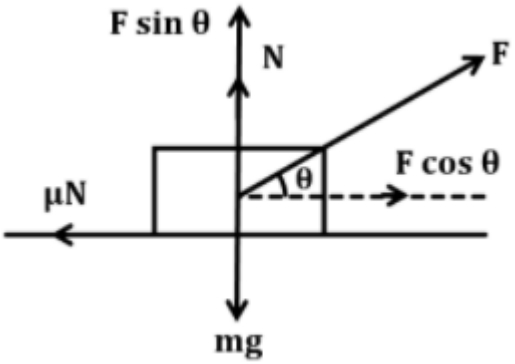
(b) $\frac{F}{m}(\cos\theta+\mu\sin\theta)+\mu g$

(c) $\frac{F}{m}(\cos\theta-\mu\sin\theta)-\mu g$

(d) $\frac{F}{m}(\cos\theta-\mu\sin\theta)+\mu g$

Answer: (a)

Solution:



So, from Diagram $\left(N=mg-F\sin\theta\right)$

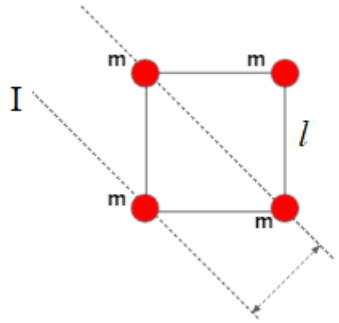
Acceleration:

$\Rightarrow ma=F\cos\theta-\mu N$

$\Rightarrow a=F\cos\theta-\mu\left(mg-F\sin\theta\right)$

$\Rightarrow a=\frac{F}{m}(\cos\theta+\mu\sin\theta)-\mu g$

Question: Find moment of inertia about the axis marked.



Options:

(a) ml^2

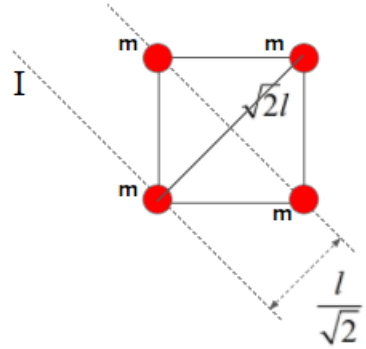
(b) $2ml^2$

(c) $3ml^2$

(d) $4ml^2$

Answer: (c)

Solution:



$$I = m\left(\frac{l}{\sqrt{2}}\right)^2 + m\left(\frac{l}{\sqrt{2}}\right)^2 + m\left(\sqrt{2}l\right)^2$$

$$= m\frac{l^2}{2} + m\frac{l^2}{2} + m \times 2l^2$$

$$= 3ml^2$$

Question: When the lift is stationary, time period of pendulum in lift is T. If the lift accelerates upward with acceleration $\frac{g}{2}$. Find new time period.

Options:

(a) $\sqrt{\frac{2}{3}}T$

(b) $\sqrt{\frac{3}{2}}T$

(c) T

(d) $\frac{T}{2}$

Answer: (a)

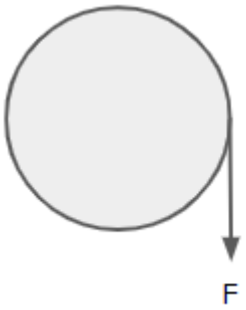
Solution:

$$T = 2\pi\sqrt{\frac{l}{g}}$$

$$T' = 2\pi\sqrt{\frac{l}{g+\frac{g}{2}}} = 2\pi\sqrt{\frac{2l}{3g}}$$

$$T' = \sqrt{\frac{2}{3}} \times 2\pi\sqrt{\frac{l}{g}} = \sqrt{\frac{2}{3}}T$$

Question: A uniform circular pulley of 20 kg and radius 0.2 m is hinged at centre. A force of 20N is acting on it as shown. It takes 'n' turns to attain angular velocity of 50 rad/s. Find n.



Options:

(a) 18

(b) 19.9

(c) 20.5

(d) 7.2

Answer: (b)

Solution:

$\tau = I\alpha$

$$rF = \frac{mr^2}{2}\alpha$$

$$0.2 \times 20 = \frac{20 \times 0.2^2}{2}\alpha$$

$$\alpha = 10\,rad/s^2$$

Now

$$\omega^2 = 2\alpha\theta$$

$$50^2 = 2 \times 10 \times \theta$$

$$\theta = 125\,rad$$

But $\theta = 2n\pi$

$$n = \frac{\theta}{2\pi} = \frac{125}{2\pi} = 19.9$$

Question: The pressure at a certain depth near a submarine is 3×10^5 Pa. If the depth is doubled then find the percentage increase in the pressure (at the new depth) is: $P_{atm} = 10^5$ Pa.

Options:

(a) 50 %

(b) 33.33 %

(c) 66.66 %

(d) 100 %

Answer: (c)

Solution:

$P = P_0 + h\rho g = 3\times10^5\, Pa$

$h\rho g = 3\times10^5 - 10^5 = 2\times10^5\, Pa$

$2h\rho g = 4\times10^5\, Pa$

$P' = P_0 + 4\times10^5 = 5\times10^5\, Pa$

% Increase in pressure $= \frac{P'-P}{P}\times100 = \frac{(5-3)10^5}{3\times10^5}\times100 = 66.66\%$

Question: For an electromagnetic wave, if $u_e =$ average energy density in electric field, and $u_m =$ average energy density in magnetic field, then which of the following relations is correct?

Options:

(a) $u_e > u_m$

(b) $u_m > u_e$

(c) $u_m = u_e$

(d) There is no definite relation between u_e and u_m

Answer: (c)

Solution:

For an electromagnetic wave, the energy associated with the electric field is equal to the energy associated with the magnetic field, so the energy density can be written in terms of just one or the other (i.e, either electric field or magnetic field):

$u_m = u_e$

Question: Length of main scale division of a vernier callipers is a cm. If $(n-1)$ divisions of main scale is equal to n divisions of vernier scale, find least count of the instrument.

Options:

(a) a cm

(b) $\frac{a}{n-1} cm$

(c) $\frac{a}{n}cm$

(d) $\frac{a}{n+1}cm$

Answer: (c)

Solution:

One main scale division, 1 M.S.D = a cm

One vernier scale division, 1 V.S.D $=\frac{(n-1)}{n}a$ cm

Least count $=1M.S.D-1V.S.D$

$=\left\{a-\frac{(n-1)}{n}a\right\}cm$

$=\frac{na-(n-1)a}{n}cm$

$=\frac{na-na+a}{n}cm$

$=\frac{a}{n}.cm$

Question: In a container of volume V all the gases have temperature T (absolute temperature). Find the total pressure?

$16g\,O_2$

$28\,g\,N_2$

$44\,g\,CO_2$

Options:

(a) $\frac{5RT}{V}$

(b) $\frac{5RT}{2V}$

(c) $\frac{3RT}{V}$

(d) $\frac{3RT}{2V}$

Answer: (b)

Solution:

$16gO_2$, No. of moles of O_2 $(n_1)=\frac{16}{32}=0.5\text{mole}$

$28gN_2$, No. of moles of $N_2(n_2)=\frac{28}{28}=1\text{mole}$

$44gCO_2$, No. of moles of $Co_2(n_3)=\frac{44}{44}=1\text{mole.}$

Total no. of moles in container $(n)=n_1+n_2+n_3$

$n=0.5+1+1=\frac{5}{2}moles.$

We know the ideal gas equation.

$$PV = nRT$$

$$P = \frac{nRT}{V}$$

$$P_{\text{total}} = \frac{5RT}{2V}$$

Question: A 25 m antenna is an a tower of height 75 m. Find the most appropriate wavelength that can be transmitted?

Options:

(a) 100 m

(b) 200 m

(c) 300 m

(d) 400 m

Answer: (a)

Solution:

The height of peak of antenna (H)=25m.

$H = 25m$

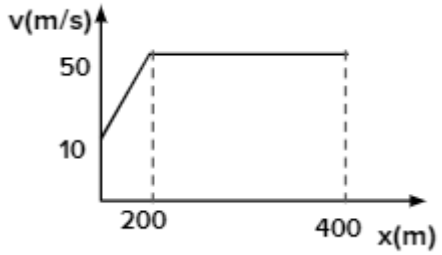
As we know height should be 4 times of the height of peak of antenna.

So, $\lambda = 4 \times H$

$\lambda = 4 \times 25$

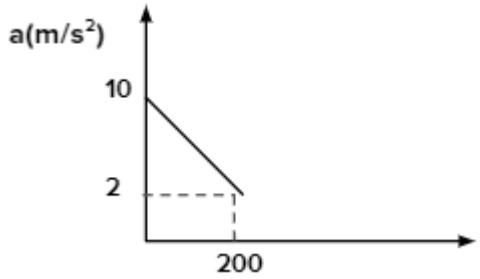
$\lambda = 100\,m.$

Question: Draw a-x graph for the given $v - x$ graph.

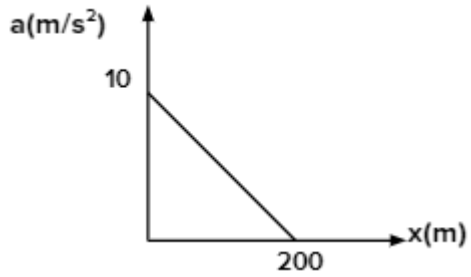


Options:

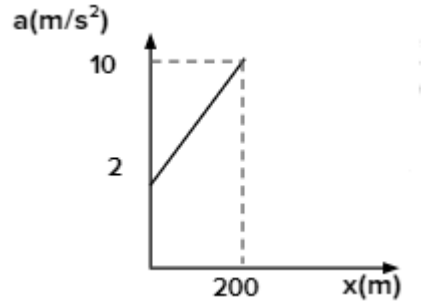
(a)



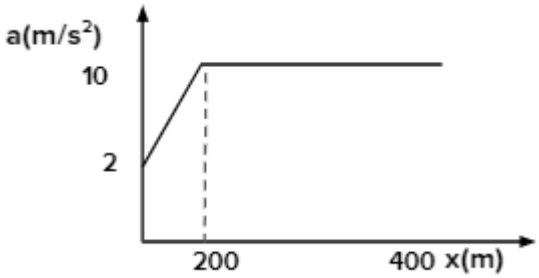
(b)



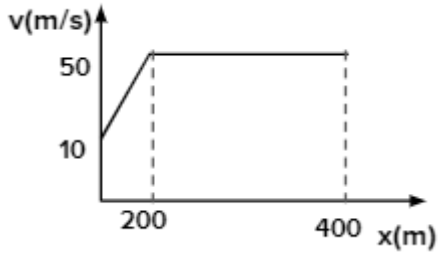
(c)



(d)



Answer: (c)
Solution:
Given $v-x$ graph



Equation of line AB

$$v-10=\frac{(50-10)}{(200-0)}\times(x-0)\ \ \{0\le x\le 200\}$$

$$v=\frac{x}{5}+10$$

$$\frac{dv}{dx}=\frac{1}{5}$$

Acceleration $a = \frac{dv}{dt} = \frac{dv}{dx}.\frac{dx}{dt}$

$a = v\left(\frac{dv}{dx}\right)$ $\qquad\qquad$ $v = \left\{\frac{dx}{dt}\right\}$

$a = \left\{\frac{x}{5} + 10\right\} \times \frac{1}{5}$

$a = \left(\frac{x}{25} + 2\right) m/s^2$

At $x = 0, a = 2m/s^2$

$x = 200, a = 10m/s^2$

Equation of line BC

$v = 50 \quad 200 \le x \le 400$

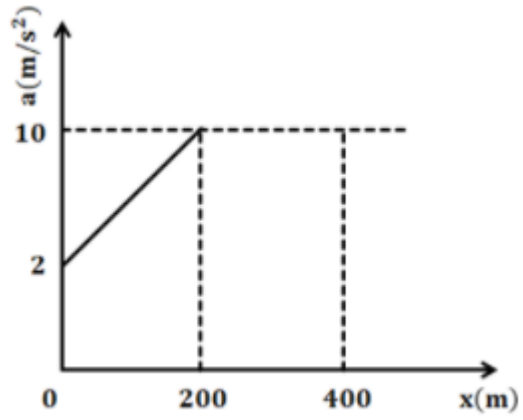
$\frac{dv}{dx} = 0$

Acceleration $(a) = v\left(\frac{dv}{dx}\right)$

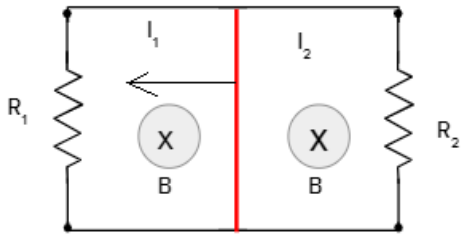
$= 50 \times 0$

$a = 0\, m/s^2$

So,



Question: In the given figure, what will be the directions of current I_1 and I_2?



Options:

(a) $I_1 \rightarrow$ clockwise, $I_2 \rightarrow$ anticlockwise

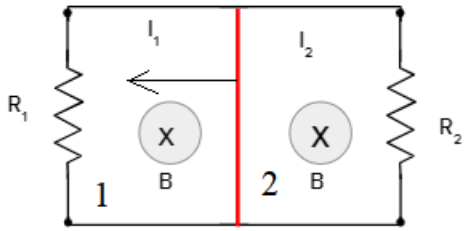
(b) $I_1 \rightarrow$ anticlockwise, $I_2 \rightarrow$ clockwise

(c) Both clockwise

(d) Both anticlockwise

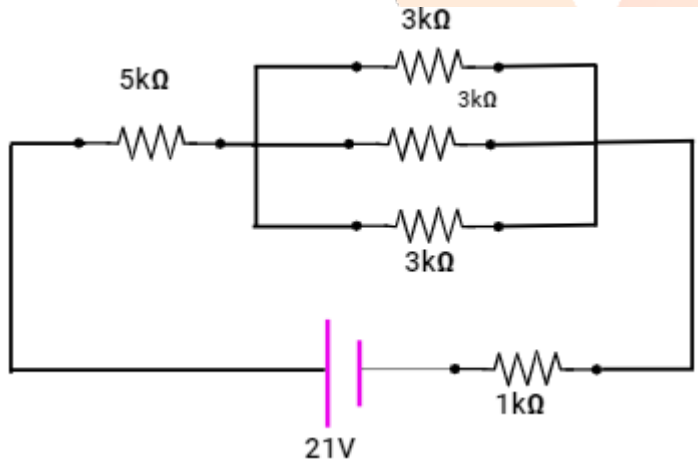
Answer: (a)

Solution:



Area of loop 1 decreases and that of loop 2 increases. Magnetic flux decreases in 1 and increases in 2. Induced emf and current should be to resist this change. As a result, B should increase in 1 and decrease in 2. So I_1 should be clockwise and I_2, anticlockwise.

Question: Find the currents in $5k\Omega$ and $3k\Omega$?



Options:

(a) 3mA, 1mA

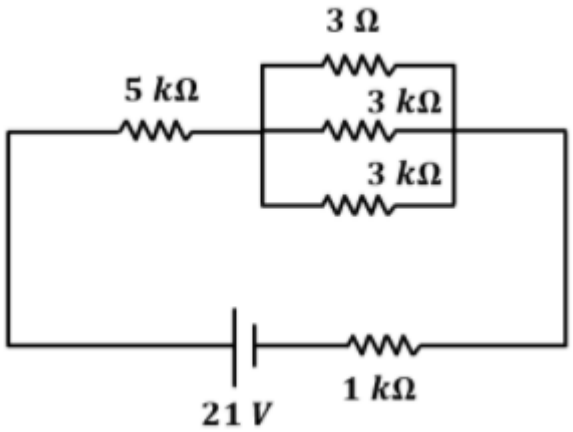
(b) 1mA, 3mA

(c) 3mA, 5mA

(d) 6mA, 2mA

Answer: (a)

Solution:

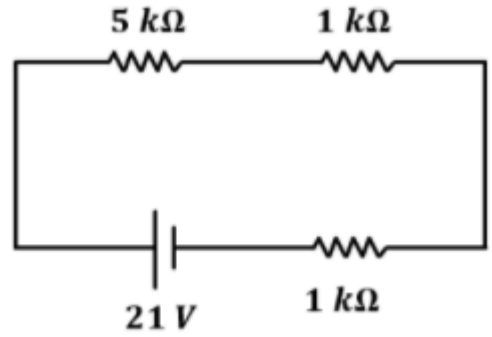


$R_{eq} = 7\,k\Omega$

$V = 21\,V$

$I = \frac{21}{7} = 3mA$

Equivalent circuit



Then, current through $5k\Omega$ is $3mA$

$\Rightarrow$ Current in $3\,k\Omega$ is $1mA$ and current through $1k\Omega$ is $3mA$

So, option A is correct.

Question: A comet is revolving around the sun in an elliptical orbit. It closest distance and farthest distance from sun are r_1 and r_2 respectively. Its speed at r_1 is v_1. What is the speed at distance r_2.

Options:

(a) $\frac{v_1 r_2}{r_1}$

(b) $\frac{v_1 r_1}{r_2}$

(c) $\frac{v_1 r_1^2}{r_2^2}$

(d) $\frac{v_1 r_2^2}{r_1^2}$

Answer: (b)

Solution:

As we know that Gravitational force is a central force, so we have,

$\vec{\tau}_{ext} = \vec{0} \Rightarrow \frac{d\vec{L}}{dt} = \vec{0}$

$\vec{L} =$ constant

We know that $\left|\vec{L}\right| = mvr$

$mv_1 r_1 = mv_2 r_2$

$v_2 = \frac{v_1 r_1}{r_2}$

Question: In Balmer series, 1st, 2nd and 3rd line have wavelength $\lambda_1, \lambda_2, \lambda_3$ respectively. Find $\frac{\lambda_1}{\lambda_3}$

Options:

(a) $\frac{7}{240}$

(b) $\frac{189}{125}$

(c) $\frac{125}{189}$

(d) $\frac{240}{7}$

Answer: (b)

Solution:

$\frac{1}{\lambda} = R\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$

$n_1 = 2$ for Balmer

For 1st line $n_2 = 3$

$\frac{1}{\lambda_1} = R\left[\frac{1}{4} - \frac{1}{9}\right]$

$\frac{1}{\lambda_1} = R\left[\frac{1}{4} - \frac{1}{9}\right]$

$\frac{1}{\lambda_1} = R\frac{5}{4\times 9} = \frac{5}{36}R$

$\lambda_1 = \frac{36}{5R}$

For 3rd line $n_2 = 5$

$$\frac{1}{\lambda_3} = R\left[\frac{1}{4} - \frac{1}{25}\right]$$

$$\frac{1}{\lambda_3} = R.\frac{21}{100}$$

$$\lambda_3 = \frac{100}{21R}$$

$$\frac{\lambda_1}{\lambda_3} = \frac{\frac{36}{5R}}{\frac{100}{21R}} = \frac{36\times 21}{5\times 100} = \frac{189}{125}$$

Question: A conductor of length l, area of cross section A and resistivity ρ has resistance $= R$. It is connected across a cell of voltage V. What will be the current flowing through resistor if its length is doubled and cross section area is halved.

Options:

(a) $\frac{V}{R}$

(b) $\frac{V}{4R}$

(c) $\frac{4V}{R}$

(d) $\frac{V}{2R}$

Answer: (b)

Solution:

We know that

$$R = \rho.\frac{l}{A}$$

Now, given is

New length $l' = 2l$

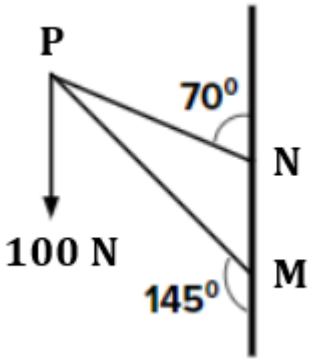
And new area of cross-section is $\frac{A}{2}$

New resistance $= \rho.\frac{2l}{A/2}$

Then current I

$$I = \frac{V}{\rho.\frac{2l}{(A/2)}} = \frac{V}{4.\frac{\rho l}{A}} = \frac{V}{4R}$$

Question: If A frame is formed by using two massless rods PM & PN. And a force(F) of 100 N is applied on the point P. If the force (F) is resolved parallel to the rods PM & PN. Then find the magnitude of force (F) along rod PN.



Options:

(a) $100\cos 20°N$

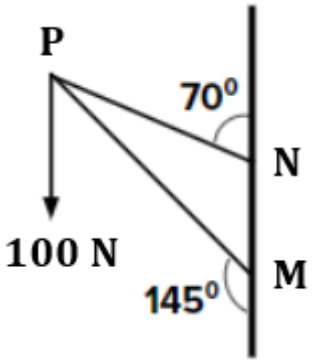
(b) $100\cos 70°N$

(c) $50\sqrt{2}N$

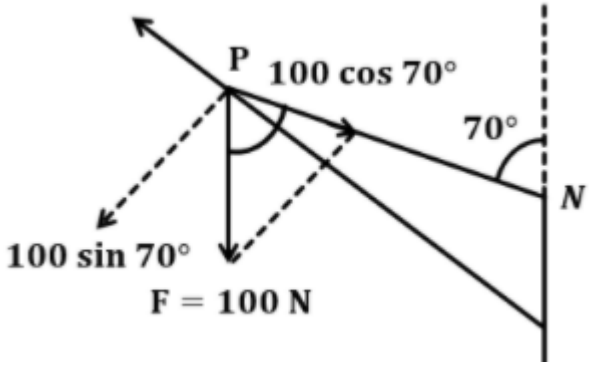
(d) $50\sqrt{3}N$

Answer: (b)

Solution:



Taking PN rod and making FBD of PN rod.

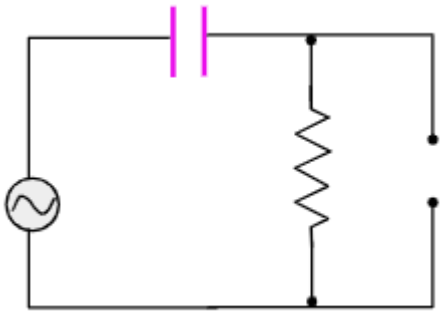


From FBD

Component of force F along PN is $100\cos 70°N$

So, option b is correct

Question: If the input voltage is a square voltage in the AC source, what would be the nature of output voltage.

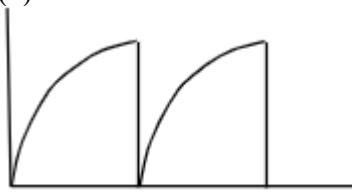


Options:

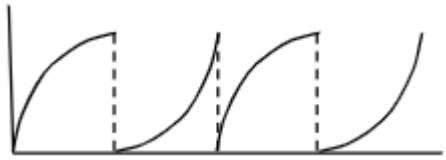
(a)

(b)

(c)



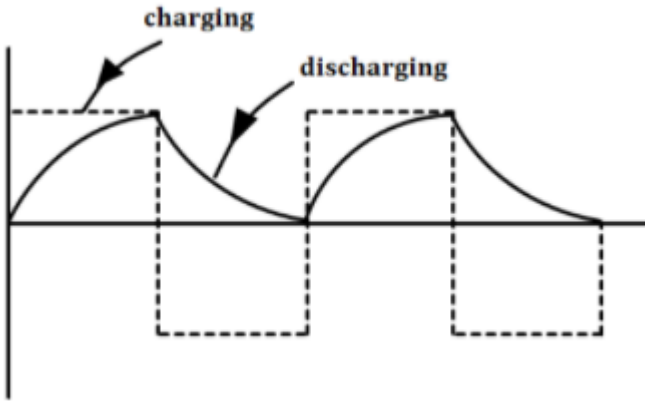
(d)

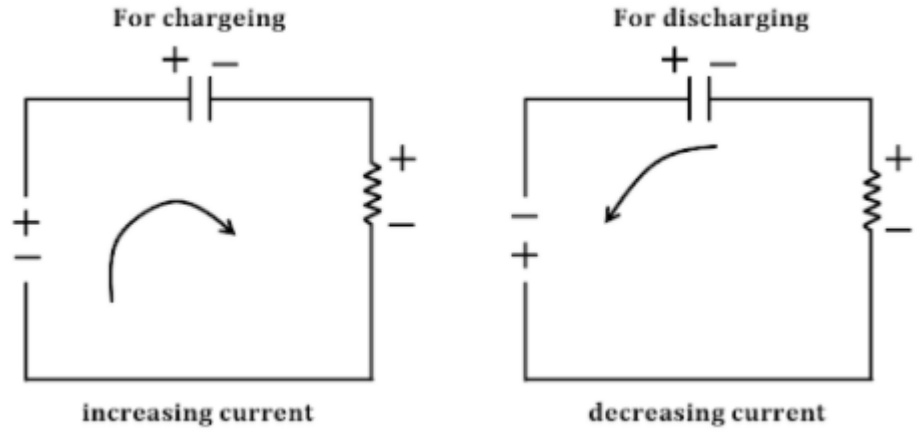


Answer: (b)

Solution:

Assuming, AC start with positive voltage. When +ve voltage is across input then the capacitor start changing try to reach saturation value till positive voltage across input.When – ve voltage of ac appears on input , the capacitor start discharging and try to reach minimum till the -ve voltage appears at input then again re-start changing till +ve voltage appear to input then start discharging when – ve voltage across the input and this process will continues with input and most suitable output for this input will be:-


charging
discharging


For chargeing
For discharging
increasing current
decreasing current

JEE-Main-16-03-2021-Shift-1 (Memory Based)

CHEMISTRY

Question: Which vitamin is stored in body for a long time?

Options:

(a) Vitamin A and Vitamin D
(b) Ascorbic acid and Vitamin D
(c) Vitamin A and thymine
(d) Ascorbic acid and vitamin D
Answer: (a)

Solution: The fat-soluble vitamins A, D, E and K can be locked away in the liver and body fat, and stored for a long time.

Question: Sulphur can be removed from ore by
Options:

(a) Roasting
(b) Smelting
(c) Calcination
(d) Magnetic separation

Answer: (a)

Solution: Roasting removes the sulphur from ores and convert it into SO_2 gas

Question: S1: Bond angle of H_2O is 104.5^o

S2: lp-lp repulsion is higher than bp-bp repulsion
Options:

(a) S1 and S2 both are correct

(b) S1 is correct and S2 is incorrect

(c) S2 is correct and S1 is incorrect

(d) S1 and S2 both are correct

Answer: (a)

Solution: lp-lp repulsion is higher than lp-bp and bp-bp which results in decrease of bond angle from 109.5^o to 104.5^o

Question: λ_1, λ_2, λ_3, are the first 3 lines of balmer series. Find λ_1/λ_3

Options:

(a) 1.8

(b) 1.5

(c) 1.6

(d) 1.7

Answer: (b)

Solution:

$$\lambda_1 = \frac{1}{R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)}$$

$$= \frac{1}{R\left(\frac{1}{4} - \frac{1}{9}\right)} = \frac{36}{5R}$$

$$\lambda_3 = \frac{1}{R\left(\frac{1}{4} - \frac{1}{25}\right)} = \frac{100}{21R}$$

$$\frac{\lambda_1}{\lambda_3} = \frac{\frac{36}{5R}}{\frac{100}{21R}} = 1.5$$

Question: A metal in group 15 forms a hydride and it is strongest reducing agent in the group :

Options:

(a) SbH_3

(b) PH_3

(c) BiH_3

(d) NH_3

Answer: (c)

Solution: Ammonia is only a mild reducing agent while BiH_3 is the strongest reducing agent amongst all the hybrids. Basicity also decreases in the order

$NH_3 > PH_3 > AsH_3 > SbH_3 > BiH_3$

Question: Aspirin is also known as
Options:

(a) 2-Acetoxy benzoic acid

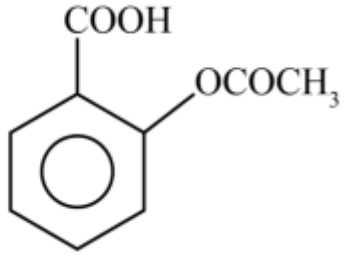
(b) 1-acetoxy ben-2-oic acid

(c) 4-amino benzoic acid

(d) 2-hydroxy benzoic acid

Answer: (a)

Solution:

Aspirin = 

Question: S1: H_2O_2 can act as both oxidising agent and reducing agent in basic medium.
S2: In hydrogen economy energy is transferred in the form of H_2
Options:

(a) Both S1 and S2 are correct
(b) S1 is correct, S2 is wrong
(c) S2 is correct, S1 is wrong
(d) Both S1 and S2 are wrong
Answer: (a)

Solution:

Oxidising action in basic medium

$2Fe^{2+} + H_2O_2 \rightarrow 2Fe^{3+} + 2OH^-$

$Mn^{2+} + H_2O_2 \rightarrow Mn^{4+} + 2OH^-$

Reducing action in basic medium

$I_2 + H_2O_2 + 2OH^- \rightarrow 2I^- + 2H_2O + O_2$

$2MnO_4^- + 3H_2O_2 \rightarrow 2MnO_2 + 3O_2 + 2H_2O + 2OH^-$

Question: Match the following

Column I (Acids)	**Column II (Oxidation States)**
(A) Hypophosphorous acid	**(i)** 5
(B) Orthophosphoric acid	**(ii)** 4

(C) Hypophosphoric acid	**(iii)** 3
(D) Orthophosphorus acid	**(iv)** 1

Options:

(a) A → (iii); B → (i); C → (iv); D → (ii)

(b) A → (i); B → (ii); C → (iii); D → (iv)

(c) A → (iii); B → (ii); C → (i); D → (iv)

(d) A → (i); B → (iii); C → (ii); D → (iv)

Answer: (a)

Solution:
Hypophosphorous acid ⇒ 3
Orthophosphoric acid ⇒ 5
Hypophosphoric acid ⇒ 1
Orthophosphorus acid ⇒ 4

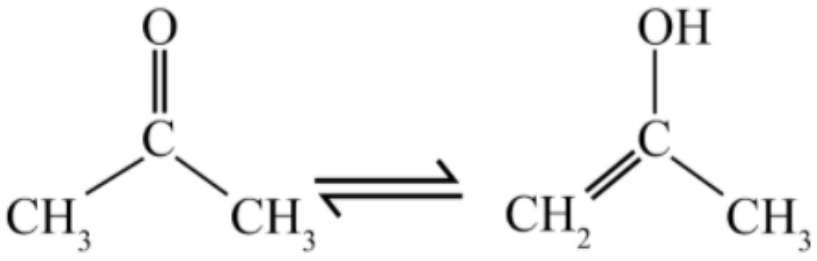
Question: S1 : enol form of acetone < 0.1 % and enol form of acetylacetone is 15 %
S2 : enol form of acetylacetone is stabilized by intramolecular H-Bonding which is not possible in acetone enol form.

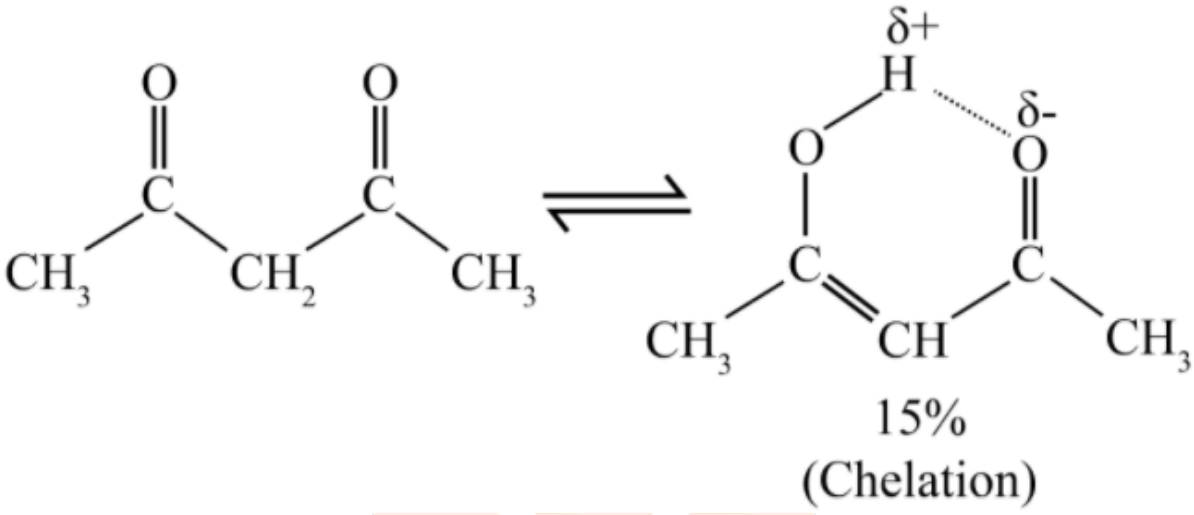
Options:

(a) Both S1 and S2 are correct
(b) S1 is correct, S2 is wrong
(c) S2 is correct, S1 is wrong
(d) Both S1 and S2 are wrong

Answer: (a)

Solution:





Question: Antihistamine is :
Options:

(a) Psychotherapeutic Drugs
(b) Antimicrobials

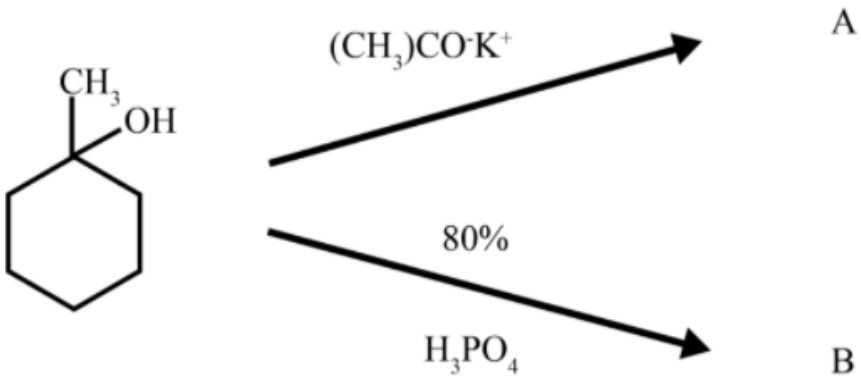
(c) Anti Allergy

(d) Disinfectants

Answer: (c)

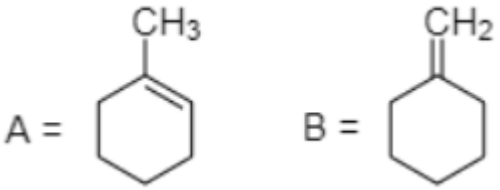
Solution: Antihistamine are drugs which treat allergic rhinitis and other allergies

Question:

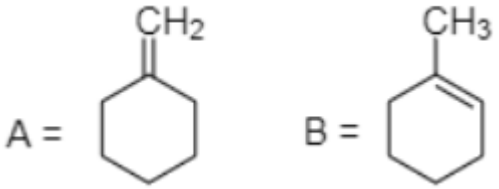


Options:

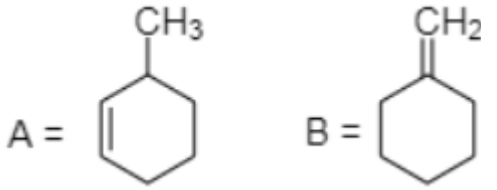
(a)



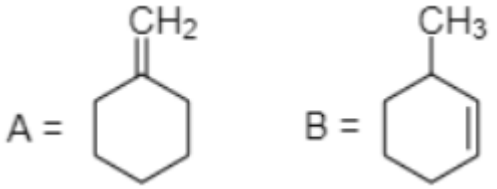
(b)



(c)

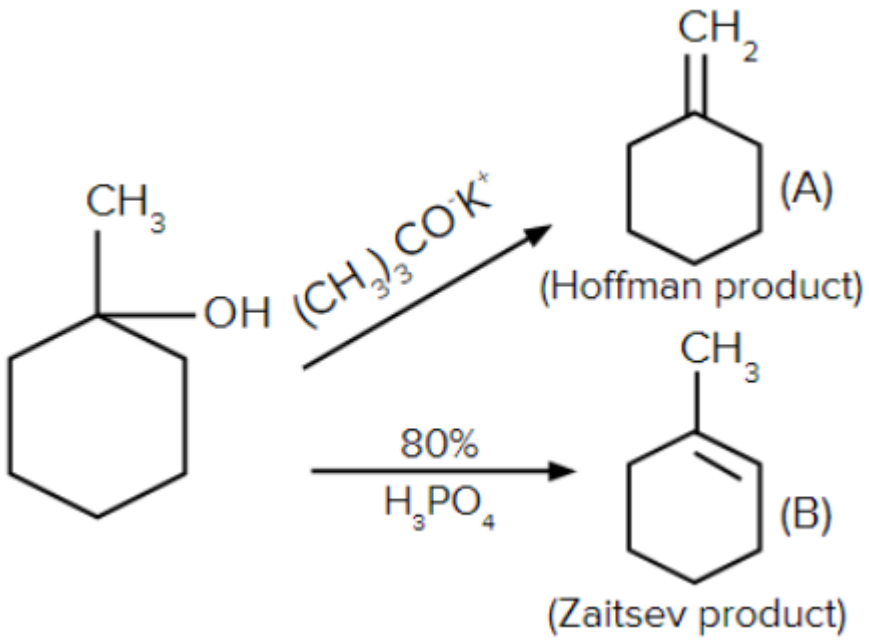


(d)



Answer: (b)

Solution:



Question: S1: Ce^{4+}/Ce^{3+} = 1.74 V

S2: Ce^{4+} is more stable than Ce^{3+}

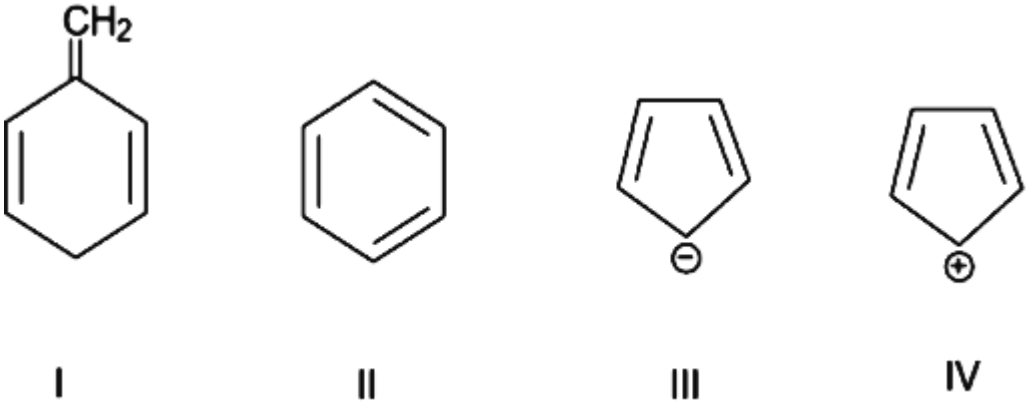
Options:

(a) Both S1 and S2 are correct
(b) S1 is correct, S2 is wrong
(c) S2 is correct, S1 is wrong
(d) Both S1 and S2 are wrong

Answer: (b)

Solution: Because, reduction potential is positive (+1.74 V), therefore Ce^{4+} will reduce to Ce^{3+} ion and hence Ce^{3+} ion is more stable then Ce^{4+} ion

Question: Which of the following are aromatic?



Options:

(a) II and III

(b) I and II

(c) I, II and III

(d) II and IV

Answer: (a)

Solution: Compound II and III follows Huckel's rule of $(4n + 2)\pi$ electrons
where, as compound IV is antiaromatic ($4n\pi$ electrons) and compound I is not planar due to presence of sp^3-carbon

Question: S1: $CaCl_2.6H_2O$ and $MgCl_2.8H_2O$ dehydrate on heating
S2: BeO is amphoteric and other oxides are acidic in nature
Options:

(a) Both S1 and S2 are correct
(b) S1 is correct, S2 is wrong
(c) S2 is correct, S1 is wrong
(d) Both S1 and S2 are wrong
Answer: (d)

Solution: BeO is amphoteric but other alkaline earth metal oxides are basic in nature

These salts on heating get hydrolysed

Question: Type of pollution during day in presence of O_3
Options:

(a) Acid acid
(b) Global warming
(c) Reducing smog
(d) Oxidising smog
Answer: (d)

Solution: $NO_2 \rightarrow NO + O$

$O + O_2 \rightarrow O_3$

$O_3 + NO \rightarrow NO_2 + O_2$

NO_2 is responsible for photo chemical smog which is oxidising in nature.

Question: m = 6.5, if density is 1.2 g/mol then find molarity of KOH solution

Options:

(a) 5.1 M

(b) 6.0 M

(c) 5.7 M

(d) 4.8 M

Answer: (c)

Solution:

$$\text{Density} = M\left(\frac{1}{m} + \frac{M.wt}{1000}\right)$$

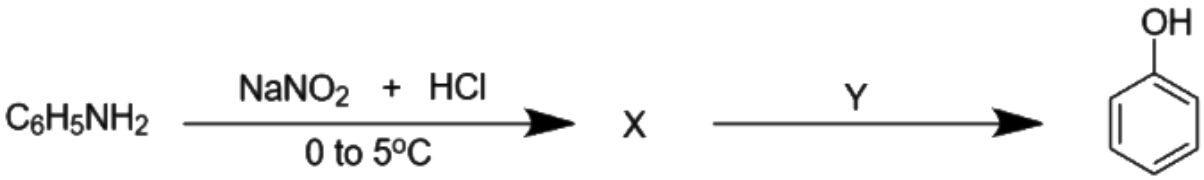
$$1.2 = M\left(\frac{1}{6.5} + \frac{56}{1000}\right)$$

$1.2 = M\ (0.15 + 0.056)$

$1.2 = M \times 0.21$

Molarity = 5.7 M

Question:

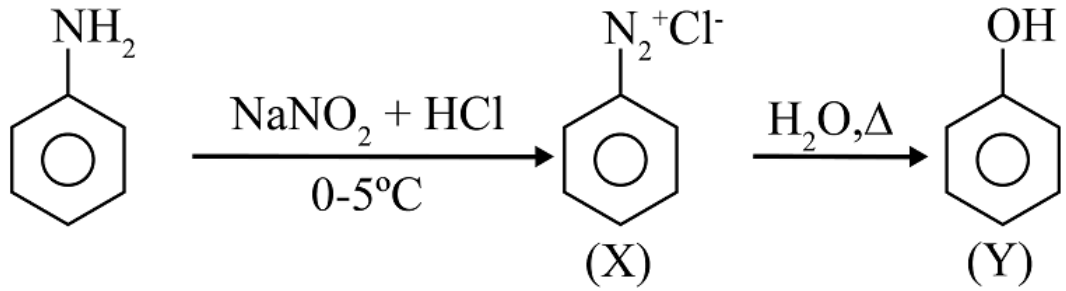


'X' and 'Y' respectively are

Options:

(a) $C_6H_5N_2^+Cl^-$ and H_2O, Δ
(b) $C_6H_5N_2^+Cl^-$ and H_2O, NaOH
(c) $C_6H_5NO_2$ and H_2O, Δ
(d) $C_6H_5NO_2$ and H_2O, NaOH
Answer: (a)

Solution:



Question: $C_6H_5CN \xrightarrow[Br_2, NaOH]{H^+, H_2O}$

Options:

(a) $C_6H_5CH_2NH_2$

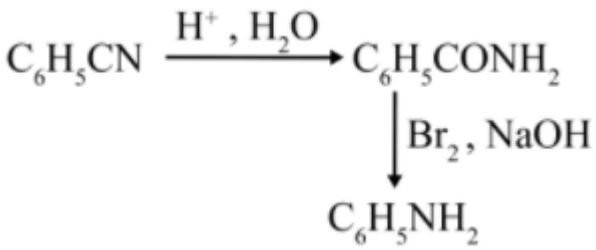
(b) $C_6H_5CONH_2$

(c) $C_6H_5NH_2$

(d) C_6H_5COOH

Answer: (c)

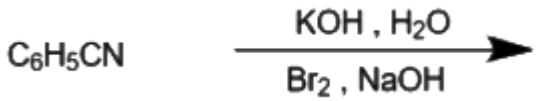
Solution:



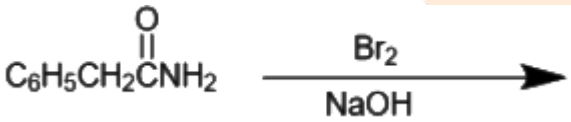
Question: Which of the following is not involved in the Hofmann Bromamide reaction?

Options:

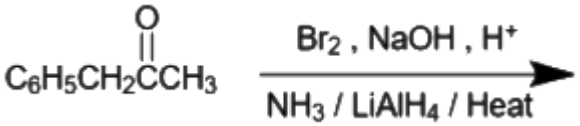
(a)



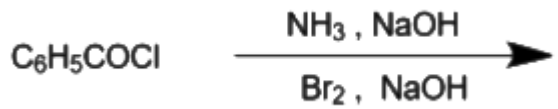
(b)



(c)

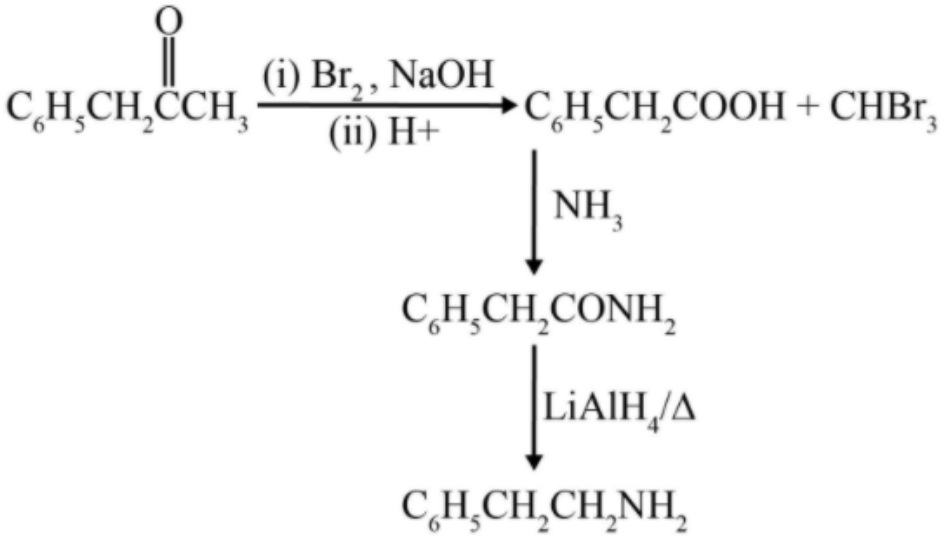


(d)

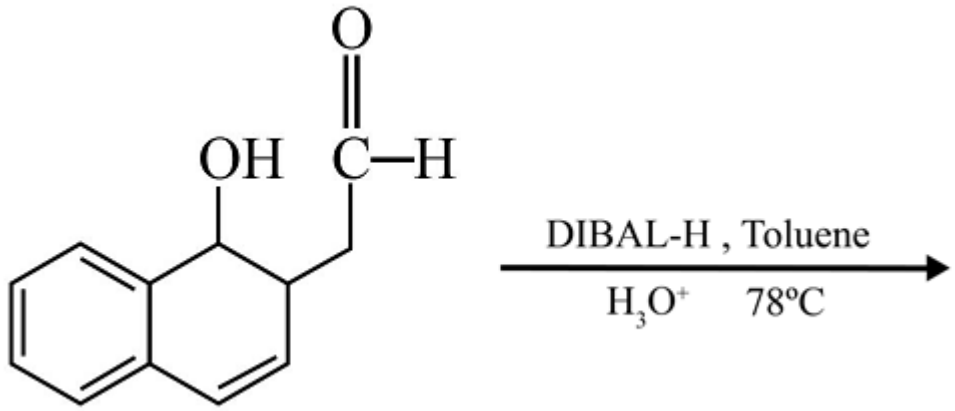


Answer: (c)

Solution:

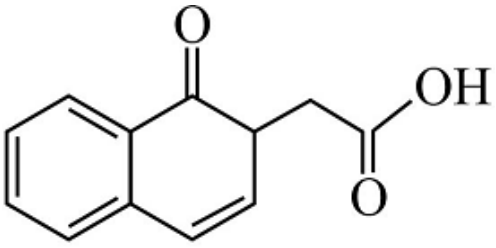


Question:

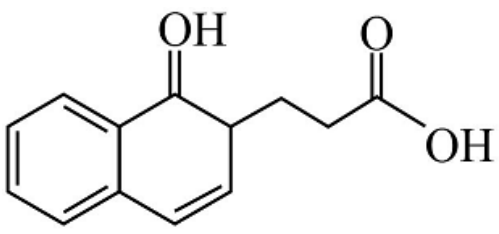


Options:

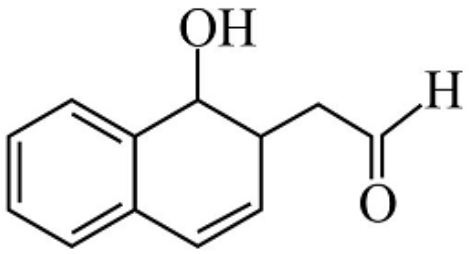
(a)



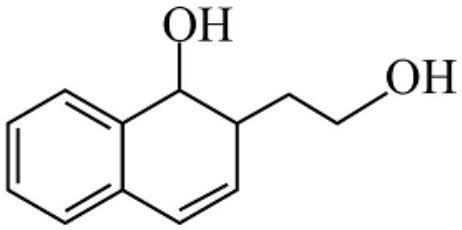
(b)



(c)

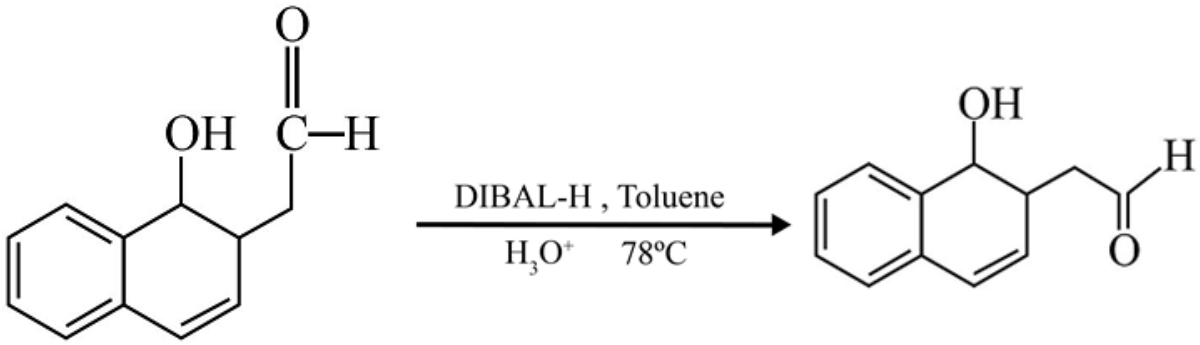


(d)



Answer: (c)

Solution:



Question: Lindlar's catalyst is :
Options:

(a) Cold dilute Alkaline $KMnO_4$
(b) $ZnCl_2$ and HCl
(c) Sodium, liquid ammonia
(d) Partially deactivated Pd, Charcoal, H_2
Answer: (d)

Solution: Lindlar's catalyst is a palladium catalyst poisoned with traces of lead and quinoline, that reduce its activity such that it can only reduce alkynes, not alkenes. It always gives the cis-alkene, in contrast to Na/NH_3, which gives the trans alkenes.

Question: Match the following

Column I (Process)	**Column II (Compound)**
(A) Haber	**(i)** HNO_3

(B) Ostwald	**(ii)** Aluminium extraction
(C) Contact	**(iii)** NH_3
(D) Hall Heroult	**(iv)** H_2SO_4

Options:

(a) A → (iii); B → (i); C → (iv); D → (ii)

(b) A → (i); B → (ii); C → (iii); D → (iv)

(c) A → (iii); B → (ii); C → (i); D → (iv)

(d) A → (i); B → (iii); C → (ii); D → (iv)

Answer: (a)

Solution: The Haber process, also called the Haber–Bosch process, is an artificial nitrogen fixation process and is the main industrial procedure for the production of ammonia today. The Ostwald process is a chemical process used for making nitric acid.

The contact process is the current method of producing sulfuric acid in the high concentrations needed for industrial processes.

The Hall–Heroult process is the major industrial process for smelting aluminium.

Question: Edge of a compound in bcc is 27Å. What will be its edge length in fcc?

Options:

(a) 63.57 Å

(b) 53.17 Å

(c) 43.07 Å

(d) 33.07 Å

Answer: (d)

Solution:

BCC: $\sqrt{3}\, a_1 = 4R$…..(1)

FCC: $a_2 = 2\sqrt{2}\, R$…..(2)

$$\frac{a_2}{a_1} = \frac{2\sqrt{2}R}{4R} \times \sqrt{3} \Rightarrow a_2 = \frac{\sqrt{3}}{\sqrt{2}} a_1$$

$a_2 = 33.07$ Å

Question: The chromatography does not depend upon?

Options:

(a) Length of column

(b) Solubility of compound

(c) Physical state

(d) Flow rate of the solvent

Answer: (a)

Solution: Conceptual

JEE-Main-16-03-2021-Shift-1 (Memory Based)

MATHEMATICS

Question: If $f(x)=\prod^{3}(x-a_i)+\sum_{i=1}^{3}a_i-3x$ where $a_i<a_{i+1}\forall i=1,2,....,$ then $f(x)=0$ has

Options:

(a) one distinct real root

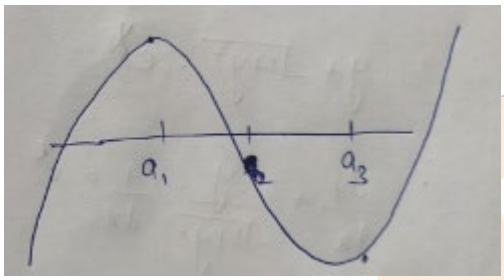
(b) 2 distinct real roots

(c) 3 distinct real roots

(d) 3 equal root

Answer: (c)

Solution:



$$f(x)=(x-a_1)(x-a_2)(x-a_3)+(a_1-x)+(a_2-x)+(a_3-x)$$

$$f(a_1)=(a_2-a_1)+(a_3-a_1)>0$$

$$f(a_2)=(a_1-a_2)+(a_3-a_2)$$

$$f(a_3)=(a_1-a_3)+(a_2-a_3)<0$$

$f(x)=0$ has 3 distinct real roots

Question: If $x=\int_0^y \frac{dt}{\sqrt{1+t^2}}$, then $\frac{d^2y}{dx^2}$ is:

Options:

(a)

(b)

(c)

(d)

Answer: ()

Solution:

$$x=\int_0^y \frac{dt}{\sqrt{1+t^2}}$$

$$\therefore \frac{dx}{dy}=\frac{1}{\sqrt{1+y^2}} \Rightarrow \frac{dy}{dx}=\sqrt{1+y^2}$$

$$\frac{d^2y}{dx^2}=\frac{d}{dy}\left(\frac{dy}{dx}\right)\cdot\frac{dy}{dx}=\left(\frac{y}{\sqrt{1+y^2}}\right)\cdot\left(\sqrt{1+y^2}\right)$$

$$=y$$

Question: In a pack of 52 cards, a card I missing. If '*Z*' cards are drawn randomly and found to be of spades. Then probability that missing card is not of spades?

Options:

(a)

(b)

(c)

(d)

Answer: ()

Solution:

E_1 - lost card is not spade

E_2 - Both cards drawn is spade

$$P(E_1)=\frac{39}{52}=\frac{3}{4},\ P\left(\frac{E_2}{E_1}\right)=\frac{13}{51}\times\frac{12}{50}$$

$$P\left(E_1'\right)=\frac{1}{4},\quad P\left(\frac{E_2}{E_1'}\right)=\frac{12}{51}\times\frac{11}{50}$$

$$\therefore\ P\left(\frac{E_1}{E_2}\right)=\frac{P(E_1)\times P\left(\frac{E_2}{E_1}\right)}{P(E_1)\times P\left(\frac{E_2}{E_1}\right)+P\left(E_1'\right)\times P\left(\frac{E_2}{E_1'}\right)}$$

$$=\frac{\frac{3}{4}\times\frac{13}{51}\times\frac{12}{50}}{\frac{3}{4}\times\frac{13}{51}\times\frac{12}{50}+\frac{1}{4}\times\frac{12}{51}\times\frac{11}{50}}$$

$$=\frac{468}{600}=\frac{39}{50}$$

Question: $A=\begin{bmatrix} i & -i \\ -i & i \end{bmatrix}, A^8\begin{bmatrix} x \\ y \end{bmatrix}=\begin{bmatrix} 8 \\ 64 \end{bmatrix}$ has

Options:

(a) unique solution
(b) no solution
(c) infinite solution
(d) 2 solutions

Answer: (b)

Solution:

$$A=\begin{bmatrix} i & -i \\ -i & i \end{bmatrix}$$

$$A^2=\begin{bmatrix} i & -i \\ -i & i \end{bmatrix}\begin{bmatrix} i & -i \\ -i & i \end{bmatrix}=\begin{bmatrix} -2 & 2 \\ 2 & -2 \end{bmatrix}$$

$$A^4=\begin{bmatrix} -2 & 2 \\ 2 & -2 \end{bmatrix}\begin{bmatrix} -2 & 2 \\ 2 & -2 \end{bmatrix}=\begin{bmatrix} 8 & -8 \\ -8 & 8 \end{bmatrix}$$

$$A^8=\begin{bmatrix} 128 & -128 \\ -128 & 128 \end{bmatrix}$$

$$\therefore A^8\begin{bmatrix} x \\ y \end{bmatrix}$$

$$\Rightarrow 128x-128y=8$$

$$-128x+128y=64$$

No solution

Question: $\frac{dy}{dx}+2y\tan x=\sin x,\ y\left(\frac{\pi}{3}\right)=0,$ maximum value of $y(x)$ is

Options:

(a) $\frac{1}{8}$

(b) $\frac{1}{16}$

(c) $\frac{-15}{4}$

(d) $\frac{3}{8}$

Answer: (a)

Solution:

$$\frac{dy}{dx}+(2\tan x)y=\sin x$$

$$\text{IF}=e^{\int 2\tan x\,dx}=\sec^2 x$$

$$\therefore y(\sec^2 x)=\int \sec x\tan x\,dx=\sec x+c$$

$\because\ y\left(\frac{\pi}{3}\right)=0 \Rightarrow 0=2+c \Rightarrow c=-2$

$\therefore\ y\sec^2 x=\sec x-2$

$y=\cos x-2\cos^2 x$

For $y_{\max} \Rightarrow \frac{dy}{dx}=0 \Rightarrow -\sin x+4\cos x\sin x=0$

$\sin x=0 \quad \text{or} \quad \cos x=\frac{1}{4}$

$\therefore\ y_{\max}=\frac{1}{4}-2\times\frac{1}{16}=\frac{1}{8}$

Question: $81^{\cos^2 x}+81^{\sin^2 x}=30$ number of solutions of $x\in(0,\pi)$

Options:

(a) 0
(b) 2
(c) 8
(d) 4

Answer: (d)

Solution:

$(81)^{\cos^2 x}+(81)^{\sin^2 x}=30$

$\frac{(81)}{(81)^{\sin^2 x}}+(81)^{\sin^2 x}=30$ (Put $81^{\sin^2 x}=t$)

$t^2-30t+81=0$

$(t-27)(t-3)=0 \Rightarrow t=3,27$

$(81)^{\sin^2 x}=3,27$

$\sin^2 x=\frac{1}{4},\frac{3}{4}$

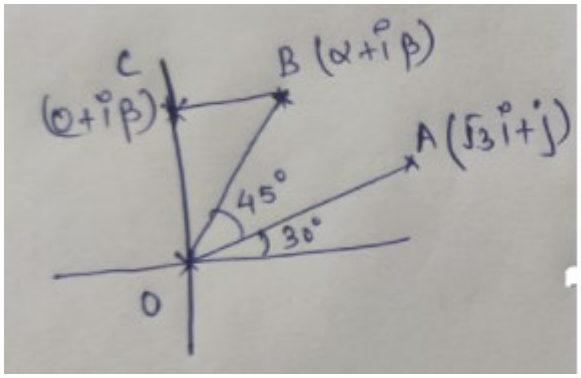
$\sin x=\pm\frac{1}{2},\pm\frac{\sqrt{3}}{2}$

$\therefore$ Number of solution in $x\in(0,\pi)$ is 4

Question: $\alpha\hat{i}+\beta\hat{j}$ is obtained by rotating $\sqrt{3}\hat{i}+\hat{j}$ by $45°$ in counter clockwise direction about only $45°$. Find area of Δ made by $(0,0),(0,\beta)$ and (α,β).

Options:

(a)
(b)
(c)
(d)
Answer: ()
Solution:



Coordinates of B is $\left(2\cos 75°, 2\sin 75°\right)$, i.e.

$$\alpha + i\beta = \left[\left(\frac{\sqrt{3}-1}{\sqrt{2}}\right) + i\left(\frac{\sqrt{3}+1}{\sqrt{2}}\right)\right]$$

$$\therefore \text{ Area of } \Delta OBC = \frac{1}{2}\times\alpha\times\beta = \frac{1}{2}\times 2\times\frac{1}{2} = \frac{1}{2}$$

Question: $\sum_{r=1}^{\infty}\tan^{-1}\left(\frac{6^r}{2^{2r+1}+3^{2r+1}}\right)$

Options:
(a)
(b)
(c)
(d)
Answer: ()
Solution:

$$\sum_{r=1}^{\infty}\tan^{-1}\left[\frac{6^r}{2^{2r+1}+3^{2r+1}}\right] = \sum_{r=1}^{\infty}\tan^{-1}\left[\frac{\frac{3^r.2^r}{2^{2r+1}}}{1+\left(\frac{3}{2}\right)^{2r+1}}\right]$$

$$= \sum_{r=1}^{\infty}\tan^{-1}\left[\frac{\frac{3.6^r - 2.6^r}{2^{2r+1}}}{1+\left(\frac{3}{2}\right)^{r+1}\cdot\left(\frac{3}{2}\right)^{r}}\right] = \sum_{r=1}^{\infty}\tan^{-1}\left(\frac{\left(\frac{3}{2}\right)^{r+1}-\left(\frac{3}{2}\right)^{r}}{1+\left(\frac{3}{2}\right)^{r+1}\cdot\left(\frac{3}{2}\right)^{r}}\right)$$

$$= \sum_{r=1}^{\infty}\tan^{-1}\left(\frac{3}{2}\right)^{r+1} - \tan^{-1}\left(\frac{3}{2}\right)^{r}$$

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

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

$$= \cot^{-1}\left(\frac{3}{2}\right)$$

Question: $a+2, b+2, c+2$ are 3 observations such that $b = a+c$ $a+2, b+2, c+2$ has standard deviation = d. Then

Options

(a) $b^2 = 3\left(a^2 + c^2 + d^2\right)$

(b) $b^2 = a^2 + c^2 - \frac{d^2}{9}$

(c) $b^2 = a^2 + c^2 + \frac{d^2}{9}$

(d) $b^2 = 3\left(a^2 + c^2\right) - 9d^2$

Answer: (d)

Solution:

$x_1 = a+2,\ x_2 = b+2,\ x_3 = c+2,\ n = 3$

$$\overline{x} = \frac{\sum x_i}{n} = \frac{a+b+c+6}{3} = \frac{2(a+c)+6}{3} = \frac{a+b+c}{3} + 2$$

$$\therefore S.D. = \sqrt{\frac{\sum x_i^2}{n} - \left(\frac{\sum x_i}{n}\right)^2} = d = \sqrt{\frac{\sum\left(x_i - \overline{x}\right)^2}{n}}$$

$$27d^2 = \left(2a-b-c\right)^2 + \left(2b-a-c\right)^2 + \left(2c-a-b\right)^2$$

$$27d^2 = 6\left(a^2+b^2+c^2\right) - 6\left(ab+bc+ca\right)$$

$$9d^2 = 2\left(a^2+b^2+c^2-ab-bc-ca\right)$$

$$9d^2 = 2\left(a^2+c^2\right) + 2b^2 - 2b^2 - 2ac \quad ...(\text{i})$$

$$b^2 = \left(a+c\right)^2 = a^2+c^2+2ac \quad ...(\text{ii})$$

Adding (i) and (ii), we get

$$b^2 + 9d^2 = 3\left(a^2+c^2\right)$$

$$\therefore b^2 = 3\left(a^2+c^2\right) - 9d^2$$

Question: Which one of the following Boolean expression is a tautology?
Options
(a) $(p \wedge q) \vee (p \rightarrow q)$
(b) $(p \vee q) \wedge (p \rightarrow q)$
(c) $(p \wedge q) \wedge (p \rightarrow q)$
(d) $(p \wedge q) \rightarrow (p \rightarrow q)$
Answer: (d)
Solution:

Question: The locus of the midpoints of the chord of the circle $x^2 + y^2 = 25$ which is tangent of the hyperbola $\frac{x^2}{9} - \frac{y^2}{16} = 1$ is
Options:
(a)
(b)
(c)
(d)
Answer: ()
Solution:
Equation of chord with P(h, k) as mid-point to the circle $x^2 + y^2 = 25$ is $T = s_1$

$$\Rightarrow hx + ky = h^2 + k^2 \Rightarrow y = \left(\frac{-h}{k}\right)x + \left(\frac{h^2 + k^2}{k}\right) \quad ...(1)$$

$\because$ line (1) is tangent to hyperbola $\frac{x^2}{9} - \frac{y^2}{16} = 1$

$\therefore c^2 = a^2m^2 - b^2$

$$\Rightarrow \left(\frac{h^2 + k^2}{k}\right) = \frac{9h^2}{k^2} - 16$$

$$\Rightarrow \left(h^2 + k^2\right)^2 = 9h^2 - 16k^2$$

$\therefore$ locus is $\left(x^2 + y^2\right)^2 = 9x^2 - 16y^2$

Question: Sum of values of x and y satisfying $3^x - 4^y = 77; 3x^{\frac{x}{2}} - 2^y = 7$
Answer: 5.00
Solution:
1. $3^x - 4^y = 77 \quad ...(\text{i})$

$3^{\frac{x}{2}} - 2^y = 7$ (By squaring both sides)

$3^x + 4^y - 2 \cdot 3^{\frac{x}{2}} \cdot 2^y = 49 \quad \ldots(\text{ii})$

Add (i) and (ii), $2 \cdot 3^x - 2 \cdot 3^{\frac{x}{2}} \cdot 2^y = 126$

$3^{\frac{x}{2}}\left[3^{\frac{x}{2}} - 2^y\right] = 63 \qquad 3^4 - 4^y = 77$

$3^{\frac{x}{2}}(7) = 63 \qquad 4^y = 4$

$3^{\frac{x}{2}} = 9 \qquad y = 1$

$x = 4$

$\therefore x + y = 5$

Question: Let $f(x) = \int_0^x (a-1)\left(t^2 + t + \perp\right)^2 - (a+1)\left(t^4 + t^2 + 1\right) dt.$

Then find the total number of integral values of a for which $f'(x) = 0$ has no real root

Answer: 3.00

Solution:

$f'(x) = (a-1)\left(x^2 + x + 1\right)^2 - (a+1)\left(x^4 + x^2 + 1\right)$

$= (a-1)\left(x^2 + x + 1\right)^2 - (a+1)\left[x^4 + 2x^2 - x^2 + 1\right]$

$= (a-1)\left(x^2 + x + 1\right)^2 - (a+1)\left(x^2 + x + 1\right)\left(x^2 - x + 1\right)$

$= \left(x^2 + x + 1\right)\left[(a-1)\left(x^2 + x + 1\right) - (a+1)\left(x^2 - x + 1\right)\right]$

$= \left(x^2 + x + 1\right)\left[2ax - 2x^2 - 2\right] = 0$

$f(x) = 2\left(x^2 + x + 1\right)\left(x^2 - ax + 1\right) = 0$

For no real roots $D < 0$

$a^2 < 4 \Rightarrow a \in (-2, 2)$

Integral values of a are -1, 0, 1

Question: A 3×3 matrix is formed from {0, 1, 2, 3} and sum of diagonal elements of AA^T is 9. Find number of such matrices.

Answer: 766.00

Solution:

$tr\left(AA^T\right)=9$

$\Rightarrow {a_{11}}^2+{a_{12}}^2+{a_{13}}^2+....{a_{33}}^2=9$

(I) Any one element is 3 & rest all $0 \Rightarrow {}^9C_1\times{}^8C_8$

(II) All are one $\Rightarrow {}^9C_9$

(III) Any two are '2', one is '1' and six are '0' $\Rightarrow {}^9C_6\times{}^3C_1\times{}^2C_2$

(IV) Any one is '2', five is '1' and three are '0' $\Rightarrow {}^9C_3\times{}^6C_5\times{}^1C_1$

$\therefore$ Total matrix $=9+1+252+504=766$

Question: $\lim\limits_{x\to0}\dfrac{ae^x+b\sin x-ce^{-x}}{x\sin x}=2$ then $a+b+c=?$

Answer: 4.00

Solution:

$\lim\limits_{x\to0}\dfrac{ae^x-b\cos x+ce^{-x}}{x\sin x}=2 \Rightarrow a-b+c=0$

$=\lim\limits_{x\to0}\dfrac{ae^x+b\sin x-ce^{-x}}{2x}=2\Rightarrow a-c=0$

$=\lim\limits_{x\to0}\dfrac{ae^x+b\cos x+ce^{-x}}{2x}=2 \Rightarrow a+b+c=4$

Question: $\sqrt{x+14-8\sqrt{x-2}}+\sqrt{x+23-10\sqrt{x-2}}=3$ Find number of real roots.

Answer: 2.00

Solution:

$\sqrt{x+14-8\sqrt{x-2}}+\sqrt{x+23-10\sqrt{x-2}}=3$

$\left|\sqrt{x-2}-4+\sqrt{x-2}-5\right|=3$

Case I: $\sqrt{x-2}<4\Rightarrow x<18$

$4-\sqrt{x-2}+5-\sqrt{x-2}=3$

$2\sqrt{x-2}=6$

$\Rightarrow x=11$

Case II: $4<\sqrt{x-2}<5$

$\sqrt{x-2}-4+5-\sqrt{x-2}=4$

No solution

Case III: $\sqrt{x-2} > 5 \Rightarrow x > 27$

$2\sqrt{x-2} = 12 \Rightarrow x = 38$

$\therefore$ Number of real roots are two

Question: $\log_{10} \sin x + \log_{10} \cos x = -1 \log_{10}(\sin x + \cos x) = \frac{1}{2}\left[\log_{10}(n) - 1\right]$, Then n =

Answer: 12.00
Solution:

$\sin x \cos x = \frac{1}{10}$

$\log_{10}\left[1 + 2\sin x \cos x\right] = \log_{10}(n) - 1$

$\Rightarrow \log_{10}\left(\frac{6}{5}\right) = \log_{10}\left(\frac{n}{10}\right)$

$\Rightarrow n = \frac{10 \times 6}{5} = 12$

Question: Number of solutions of
$\left(|x| - 3\right)|x + 4| = 6$

Answer: 2.00
Solution:

$\left(|x| - 3\right)|x + 4| = 6$

Case I: $x < -4$

$(x + 4)(x + 3) = 6$

$\Rightarrow x^2 + 7x + 6 = 0$

$\Rightarrow x = -1, -6$

$\Rightarrow x = -6$

Case II: $-4 < x < 0$

$(x + 4)(x + 3) + 6 = 0$

$\Rightarrow x^2 = 7x + 18 = 0$

No real root

Case III: $x > 0$

$(x+4)(x-3)=6$

$x^2+x-18=0$

$\therefore x=\dfrac{-1\pm\sqrt{D}}{2}\Rightarrow x=\dfrac{-1+\sqrt{D}}{2}$ (one solution)

$\therefore$ Total number of solutions = 2

Question: If n is the number of irrational terms in the expansion $\left(3^{\frac{1}{4}}+5^{\frac{1}{8}}\right)^{60}$, then $(n-1)$ is divisible by

Answer: 13.00

Solution:

$T_{r+1}={}^{60}C_r\,(3)^{\frac{60-r}{4}}\,(5)^{\frac{r}{8}}$

For rational terms $\Rightarrow r=0,8,16,24,32,40,48,56$

$\therefore$ Total rational terms = 8

$\therefore$ Total irrational terms = $n=61-8=53$

$\therefore$ $n-1=52$ is divisible by 13