

JEE-Main-26-02-2021-Shift-2 (Memory Based)

PHYSICS

Question: If a wire of length l has a resistance of R , is stretched by 25%. The percentage change in its resistance is?

Options:

- (a) 25%
- (b) 50%
- (c) 45.25%
- (d) 56.25%

Answer: (d)

Solution:

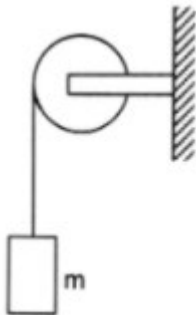
$$R = \rho \frac{l}{A} = \rho \frac{l^2}{V} \quad (\because V = Al)$$

$$R' = \rho \frac{(1.25)^2 l^2}{V} = 1.5625R$$

$$\%R = \left(\frac{R' - R}{R} \right) 100 = (1.5625 - 1) \times 100$$

$$= 56.25\%$$

Question: A chord is tied to a wheel of moment of inertia I and radius r . The other end is attached to a mass 'm' as shown. If the mass 'm' falls by a height 'h' then the square of angular speed of the wheel is?



Options:

- (a) $\frac{mgh}{I + mr^2}$
- (b) $\frac{2mgh}{I + mr^2}$
- (c) $\frac{2mgh}{2I + mr^2}$
- (d) $\frac{mgh}{2I + mr^2}$

Answer: (b)

Solution:

Considering no slipping between chord and wheel and considering no energy loss due to friction.

So, by Energy Conservation:-

$$mgh = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$$

$$\Rightarrow mgh = \frac{1}{2}m(\omega r)^2 + \frac{1}{2}I\omega^2 \quad (\because v = \omega r)$$

$$\Rightarrow \omega^2 = \frac{2mgh}{mr^2 + I}$$

Question: What is the recoil velocity of Hydrogen atom when a photon is emitted due to corresponding transition from $n = 5$ to $n = 1$. (R = Rydberg's constant. m_H = mass of hydrogen atom)

Options:

(a) $\frac{hR}{m_H}$

(b) $\frac{hR}{25m_H}$

(c) $\frac{4hR}{25m_H}$

(d) $\frac{24hR}{25m_H}$

Answer: (d)

Solution:

Energy released during transition of e^- from $n = 5$ to $n = 1$

$$\Rightarrow E = E_5 - E_1 = Rhc \left(-\frac{1}{(5)^2} - \left(-\frac{1}{(1)^2} \right) \right)$$

$$\Rightarrow E = \frac{24}{25} Rhc \dots (i)$$

So momentum of Photon released would be:-

$$\Rightarrow E = mc^2 = (mc).c = p.c$$

Using equation (i)

$$\Rightarrow p = \frac{E}{c} = \frac{24}{25} Rh$$

So Recoil velocity of H-atom would be:

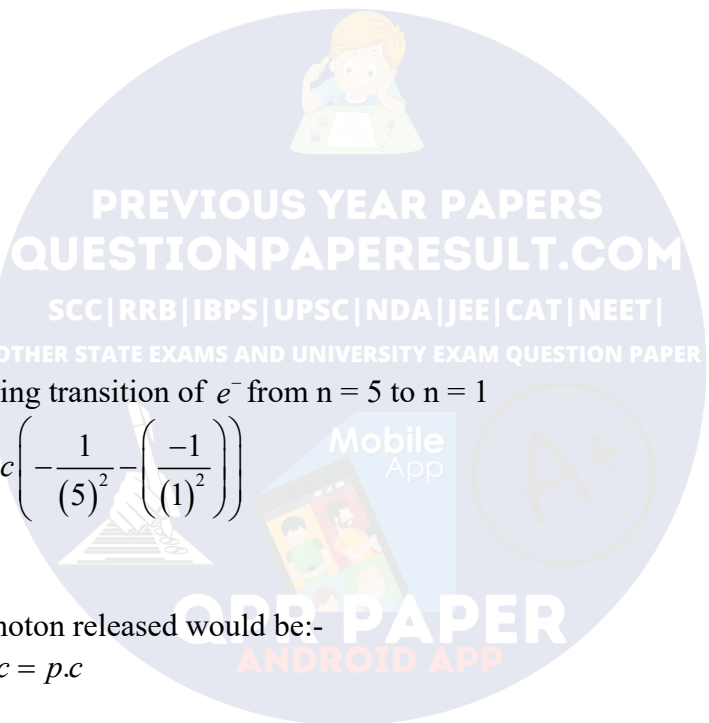
By conservation of linear Momentum.

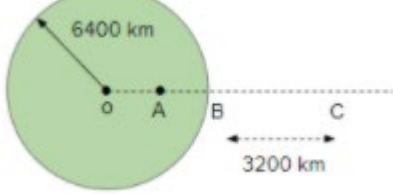
$$\Rightarrow m_H v_H = p = \frac{24}{25} Rh$$

$$v_H = \frac{24 Rh}{25 m_H}$$

Question: For earth's gravitation

Given: $[g_A = g_C < g_B]$. Find $\frac{OA}{AB}$.





Options:

- (a) 1 : 1
- (b) 2 : 3
- (c) 4 : 5
- (d) 4 : 9

Answer: (c)

Solution:

$$\Rightarrow g_C = \frac{GM}{(R + R/2)^2} = \frac{4 GM}{9 R^2} = \frac{4}{9} g$$

$$\Rightarrow g_A = g \frac{x}{R} \quad (\text{where } x = OA)$$

So, if $g_A = g_C$

$$\Rightarrow \frac{4}{9} g = g \frac{x}{R}$$

$$\Rightarrow x = \frac{4}{9} R$$

To find :- $\frac{OA}{AB} = \frac{x}{R-x} = \frac{\frac{4}{9}R}{R-\frac{4}{9}R} = \frac{4}{5}$ (Where $AB=OB-OA$ and $OB=R$)

Question: Find Dimension of $\frac{C}{V}$?

Options:

- (a) $[M^{-2}L^4T^7A^3]$
- (b) $[M^2L^4T^{-6}A^{-2}]$
- (c) $[M^2L^4T^6A^2]$
- (d) $[M^{-2}L^4T^{-6}A^2]$

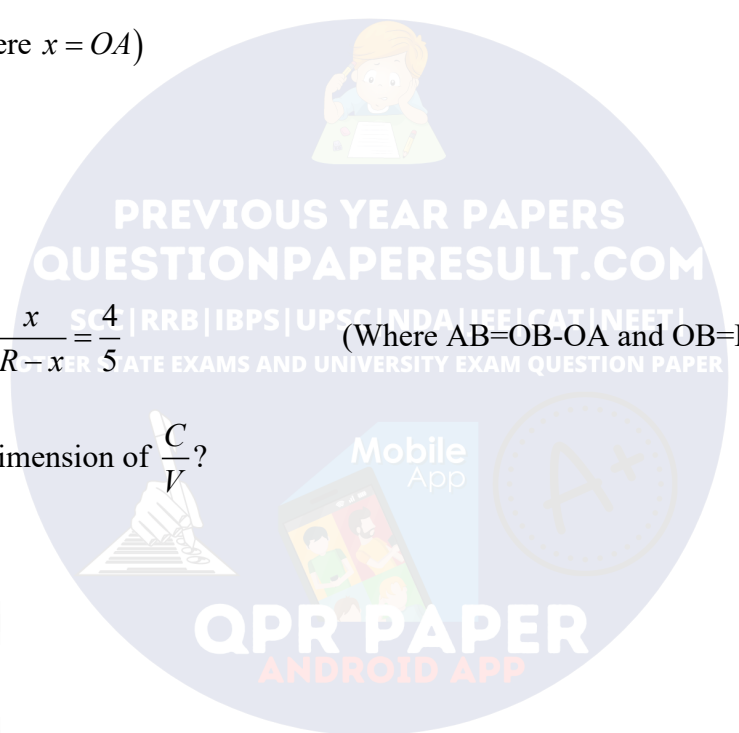
Answer: (a)

Solution:

$$\frac{C}{V} = \frac{Q}{V^2} = \frac{Q}{(W/Q)^2} = \frac{Q^3}{W^2} = \left(\frac{It}{W^2} \right)^2$$

$$\left[\frac{C}{V} \right] = \frac{[It]^3}{[W]^2} = \frac{A^3T^3}{(ML^2T^{-2})^2}$$

$$= M^{-2}L^4T^7A^3$$



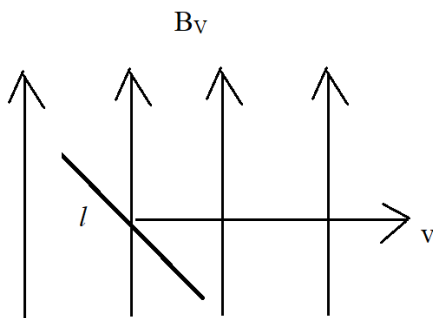
Question: An aeroplane with its wings spread 10 m is flying with speed 180 kph in horizontal direction. The total intensity of earth's field is 2.5×10^{-4} Tesla and angle of dip is 60° . Then find emf induced between the tips of the plane wings.

Options:

- (a) 108 mV
- (b) 54 mV
- (c) 216 mV
- (d) 140 mV

Answer: (a)

Solution:



$$B = 2.5 \times 10^{-4} T$$

$$\delta = 60^\circ$$

$$B_v = B \sin \delta$$

$$= 2.5 \times 10^{-4} \sin 60 = \frac{2.5\sqrt{3}}{2} \times 10^{-4} T$$

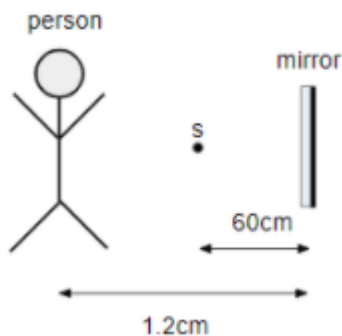
$$l = 10 m$$

$$V = 180 km/h = \frac{180 \times 5}{18} = 50 m/s$$

$$|E| = B_v l v = \frac{2.5\sqrt{3}}{2} \times 10^{-4} \times 10 \times 50$$

$$= 1082 \times 10^{-4} V = 108 \times 10^{-3} V = 108 mV$$

Question: A person walks parallel to a 50 cm wide plane mirror as shown. How much distance will he be able to see the image of a source placed 60 cm in front of it?



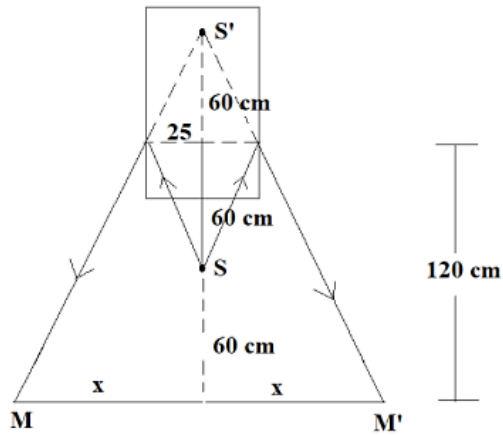
Options:

- (a) 50 cm
- (b) 100 cm
- (c) 150 cm

(d) 200 cm

Answer: (c)

Solution:



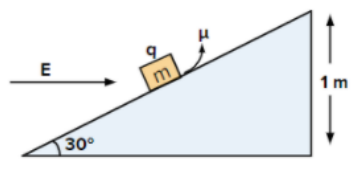
Man can see image by while traversing MM'

Now,

$$\frac{25}{60} = \frac{x}{180} \Rightarrow x = 75$$

$$MM' = 2x = 150 \text{ cm}$$

Question: Find the time taken by the block to reach the bottom of inclined plane. $E = 200 \text{ i}$
 N/C , $M = 1 \text{ kg}$, $q = 5 \text{ mC}$, $g = 10 \text{ m/s}^2$, $\mu = 0.2$

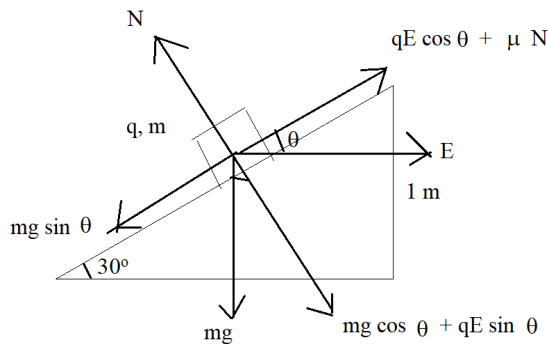


Options:

- (a) 1.35 s
- (b) 1.65 s
- (c) 1.9 s
- (d) 2.3 s

Answer: (a)

Solution:



Net force along the incline

$$F = mg \sin \theta - (\mu N + qE \cos \theta)$$

$$= mg \sin \theta - \mu(mg \cos \theta + qE \sin \theta) - qE \cos \theta$$

$$= 1 \times 10 \sin 30 - 0.2(1 \times 10 \times \cos 30 + 200 \times 5 \times 10^{-3} \times \sin 30) - 200 \times 5 \times 10^{-3} \cos 30$$

$$= 5 - 0.2(5\sqrt{3} + 0.5) - \sqrt{3} / 2$$

$$= 2.3N$$

$$a = \frac{F}{m} = \frac{2.3}{1} = 2.3 \text{ m/s}^2$$

Time taken to slide down 2 m long

$$\text{Incline } t = \sqrt{\frac{2s}{a}} = \sqrt{\frac{2 \times 2}{2.3}} = 1.32 \text{ s}$$

Question: Statement 1: A seconds pendulum, has a time period of 1 second.

Statement 2: It takes precisely 1 second to move between the two extreme position.

Options:

- (a) Statement 1 is false, Statement 2 is true
- (b) Statement 1 is true, Statement 2 is true
- (c) Statement 1 is true, Statement 2 is false
- (d) Statement 1 is false, Statement 2 is false

Answer: (a)

Solution:

[Statement 1 is false, Statement 2 is true]

A **seconds pendulum** is a **pendulum** whose **period** is precisely two **seconds**; one **second** for a swing in one direction and one second for the return swing.

So it will take 1 second to move between two extreme positions.

Thus statement 1 is false and statement 2 is true.

Question: Velocity v/s position graph of a body performing SHM is

Options:

- (a) ellipse
- (b) circle
- (c) parabola
- (d) straight line

Answer: (a)

Solution:

For SHM

$$x = A \sin \omega t \quad \dots(i)$$

$$v = \frac{d(x)}{dt} = A\omega \cos \omega t \quad \dots(ii)$$

From equation (i)

$$\sin \omega t = \frac{x}{A} \Rightarrow \sin^2 \omega t = \frac{x^2}{A^2} \quad \dots(iii)$$

From equation (ii)

$$\cos \omega t = \frac{v}{A\omega} \Rightarrow \cos^2 \omega t = \frac{v^2}{A^2 \omega^2} \quad \dots(iv)$$

Adding equation (iii) and (iv)

$$\sin^2 \omega t + \cos^2 \omega t = \frac{x^2}{A^2} + \frac{v^2}{A^2 \omega^2}$$

$$\Rightarrow 1 = \frac{x^2}{A^2} + \frac{v^2}{A^2 \omega^2}$$

This is clearly on equation of ellipse.

Question: A body starts from rest and moves with constant acceleration a , for time t_1 , then it retards uniformly with a_2 in time t_2 . Find t_1/t_2 .

Options:

(a) $\frac{a_1}{a_2}$

(b) $\frac{a_2}{a_1}$

(c) 1

(d) None of these

Answer: (b)

Solution:

For acceleration period,

$$u = 0, v = u, a = a_1, t = t_1$$

$$\text{So, } v = u = at \Rightarrow v = 0 + a_1 t_1 \Rightarrow t_1 = \frac{v}{a_1} \quad \dots(i)$$

For retardation period,

$$u = v, v = 0, a = -a_2, t = t_2$$

$$\text{So, } v = u + at \Rightarrow 0 = v - a_2 t_2, \Rightarrow t_2 = \frac{v}{a_2} \quad \dots(ii)$$

On dividing equation (i) by (ii) \rightarrow

$$\frac{t_1}{t_2} = \frac{a_2}{a_1}$$

Question: A wire has length l_1 when tension in it is T_1 & l_2 when tension is T_2 . Find the natural length of wire.

Options:

(a) $\frac{T_1 l_1 - T_2 l_2}{T_1 - T_2}$

(b) $\frac{T_1 l_2 - T_2 l_1}{T_1 - T_2}$

(c) $\frac{T_1 l_1 + T_2 l_2}{T_1 + T_2}$

(d) $\frac{T_1 l_2 + T_2 l_1}{T_1 + T_2}$

Answer: (b)

Solution:

Let the natural length of wire be l_0 .

Using Hooke's law, $Y = \frac{Tl_0}{A\Delta l}$

Where $\Delta l = l - l_0$

We get $l - l_0 = \frac{Tl_0}{AY}$

Case 1: Tension T_1 and length of wire $l = l_1$

$$\therefore l_1 - l_0 = \frac{T_1 l_0}{AY} \dots (1)$$

Case 2: Tension is T_2 and length of wire $l = l_2$

$$\therefore l_2 - l_0 = \frac{T_2 l_0}{AY} \dots (2)$$

Dividing both equations $\frac{l_1 - l_0}{l_2 - l_0} = \frac{T_1}{T_2}$

$$\Rightarrow l_0 = \frac{l_1 T_2 - l_2 T_1}{T_2 - T_1}$$

Question: A radioactive sample is undergoing α -decay. At time t_1 , its activity is A and at another time t_2 , the activity is $\frac{A}{5}$. What is the average life time for the sample

Options:

- (a) $\frac{t_2 - t_1}{\ln 2}$
- (b) $(t_2 - t_1) \ln 5$
- (c) $\frac{t_2 - t_1}{\ln 5}$
- (d) $\frac{t_2 - t_1}{2}$

Answer: (c)

Solution:

$$\text{Activity} = \left| \frac{dN}{dt} \right|$$

$$\text{At time } t_1 \quad A = N_0 \lambda e^{-\lambda t_1} \quad \dots (1)$$

$$\text{At time } t_2 \quad \frac{A}{5} = N_0 \lambda e^{-\lambda t_2} \quad \dots (2)$$

From eq (1) & (2)

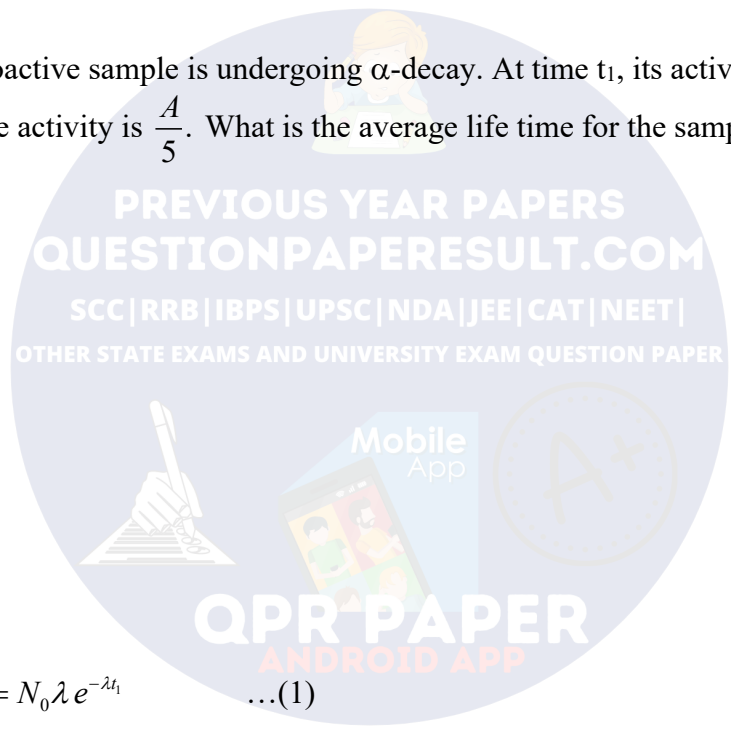
$$5 = \frac{e^{-\lambda t_1}}{e^{-\lambda t_2}}$$

$$5 = e^{-\lambda(t_1 - t_2)}$$

$$\ln 5 = -\lambda(t_1 - t_2)$$

$$\ln 5 = \lambda(t_2 - t_1)$$

$$\lambda = \frac{\ln 5}{t_2 - t_1}$$



Mean lifetime given by $\tau = \frac{1}{\lambda}$

$$\tau = \frac{t_2 - t_1}{\ln 5}$$

Question: A bike starts from rest and accelerates uniformly at 'a' m/s² for time 't₁' seconds. Then it retards with deceleration 'a' for time 't₂' seconds with till it comes to rest. Find the average speed for the entire duration.

Options:

(a) $\frac{a(t_1 + t_2)}{2}$

(b) $\frac{at_2}{2}$

(c) $\frac{at_1^2}{2}$

(d) at_1

Answer: (b)

Solution:

Average speed = $\frac{\text{total distance travelled}}{\text{total time taken}}$



Initial speed is zero.

And acceleration is a.

$$v = u + at$$

$$v = at_1$$

after time t₁

$$\& S_1 = \frac{1}{2}at_1^2$$

Now,

$$v = u + at$$

$$0 = at_1 - at_2$$

$$at_1 = at_2 \Rightarrow t_1 = t_2$$

$$S_2 = at_1t_2 - \frac{1}{2}at_2^2$$

$$\text{Total distance} = S_1 + S_2$$

$$= \frac{1}{2}at_1^2 + at_1t_2 - \frac{1}{2}at_2^2$$

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

$$S = at^2$$

$$t_1 + t_2 = 2t$$

$$\langle v \rangle = \frac{at^2}{2t}$$

$$= \frac{at}{2} = \frac{at_2}{2}$$

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Question: If incident ray, refracted ray and normal say are represented by unit vectors \vec{a}, \vec{b} and \vec{c} then relation between them is?

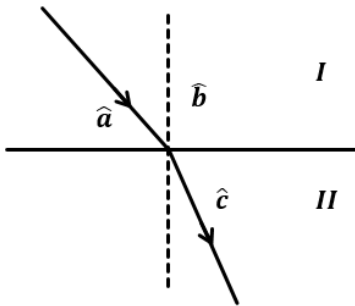
Options:

- (a) $\vec{a} - \vec{b} = \vec{c}$
- (b) $\vec{a} \cdot (\vec{b} \times \vec{c}) = 0$
- (c) $\vec{a} + \vec{c} = 2\vec{b}$
- (d) $\vec{a} \times (\vec{b} \times \vec{c}) = 0$

Answer: (b)

Solution:

Let $\mu_1 < \mu_2$



All three unit vectors are coplanar, we can say this from first law of refraction

Scalar triple product is given by $\vec{A} \cdot (\vec{B} \times \vec{C})$

If \vec{A}, \vec{B} & \vec{C} vectors are coplanar then

$$\vec{A} \cdot (\vec{B} \times \vec{C}) = 0$$

From eq. (i) we have

$$\hat{a} \cdot (\hat{b} \times \hat{c}) = 0$$

Question: If the internal energy of a gas is $U = 3PV + 4$, then the gas can be?

Options:

- (a) Monoatomic
- (b) Diatomic
- (c) Polyatomic
- (d) Either mono or diatomic

Answer: (c)

Solution:

Given, $U = 3PV + 4$

We have $PV = nRT$

$$U = 3(nRT) + 4$$

Differentiating wrt temperature

$$dU = 3.(nRdT) + 0$$

$$\frac{nfRdT}{2} = 3(nRdT)$$

$$\frac{f}{2} = 3 \Rightarrow f = 6$$

It would be triatomic, suitable option is Polyatomic.

CHEMISTRY

Question: Increasing order of $\Delta_{\text{eg}} H$ of the following elements:
O, S, Se, Te (Consider both sign and magnitude)

Options:

- (a) $S < Se < Te < O$
- (b) $O < S < Se < Te$
- (c) $S < O < Se < Te$
- (d) $O < Te < Se < S$

Answer: (a)

Solution: The values are,

$$S = -200 \text{ kJ/mol}$$

$$Se = -195 \text{ kJ/mol}$$

$$Te = -190 \text{ kJ/mol}$$

$$O = -141 \text{ kJ/mol}$$

So, considering both sign and magnitude, the order should

$$S < Se < Te < O$$

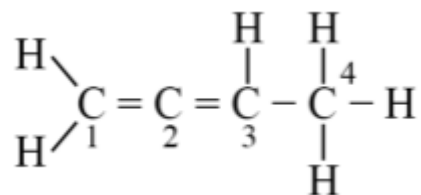
Question: Hybridisation order of the carbon atom from left to right is
 $\text{CH}_2=\text{C}=\text{CH}-\text{CH}_3$

Options:

- (a) sp^2, sp, sp^2, sp^3
- (b) sp^2, sp^2, sp^2, sp^3
- (c) sp^2, sp, sp, sp^3
- (d) sp, sp, sp^2, sp^3

Answer: (a)

Solution:



- 1 – sp
- 2 – sp
- 3 – sp²
- 4 – sp³

Question: Match the following

Column-I	Column-II
(A) Siderite	(P) Fe
(B) Calamine	(Q) Al
(C) Cryolite	(R) Zn
(D) Malachite	(S) Cu

Options:

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

Answer: (c)

Solution:

Siderite (FeCO₃) is an ore of iron

Calamine (ZnCO₃) is an ore of zinc

Cryolite (Na₃AlF₆) is an ore of Aluminium

Malachite (CuCO₃, Cu(OH)₂) is an ore of copper.

Question: Which of the following groups contains both acidic oxides:

Options:

- (a) N₂O, BaO
- (b) CaO, SiO₂
- (c) B₂O₃, SiO₂
- (d) B₂O₃, CaO

Answer: (c)


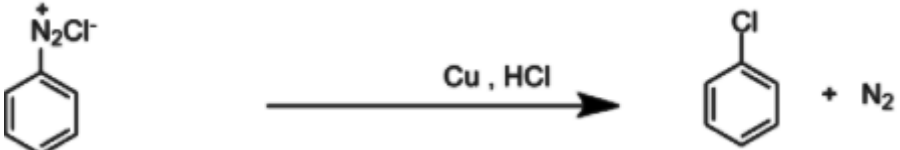
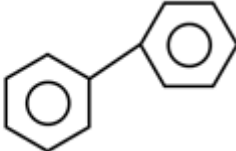
Solution:

N₂O → Neutral

BaO, CaO → Basic

B₂O₃, SiO₂ → Acidic

Question: Match the following.

Column-I	Column-II
(A) 	(P) Wurtz Reaction
(B) 	(Q) Sandmeyer Reaction
(C) $2\text{CH}_3\text{CH}_2\text{CH}_2\text{Cl} + 2\text{Na} \xrightarrow{\text{dry ether}} \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$	(R) Fittig Reaction
(D) $2\text{C}_6\text{H}_5\text{Cl} + 2\text{Na} \xrightarrow{\text{dry ether}}$ 	(S) Gattermann Reaction

Options:

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

Answer: (b)

Solution: Sandmeyer takes place with Cu⁺

Gattermann takes place with Cu^[0]

Alkyl halide coupling is Wurtz

Aryl halide coupling is Fittig Reaction

Question: Match the following.

Molecule	Bond order
(A) Ne ₂	(P) 1
(B) N ₂	(Q) 2
(C) F ₂	(R) 0
(D) O ₂	(S) 3

Options:

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

Answer: (b)

Solution: $B.O = \frac{\text{No. of bonding } e^- - \text{No. of antibonding } e^-}{2}$

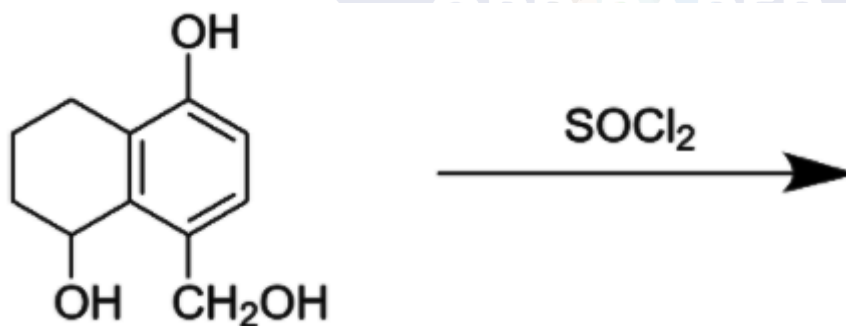
a) $Ne_2 = \frac{10-10}{2} = 0$

b) $N_2 = \frac{10-4}{2} = 3$

c) $F_2 = \frac{10-8}{2} = 1$

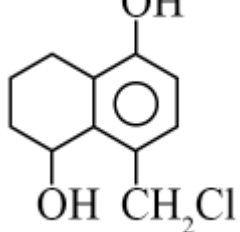
d) $O_2 = \frac{10-6}{2} = 2$

Question: Final product of the reaction

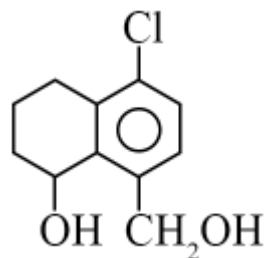


Options:

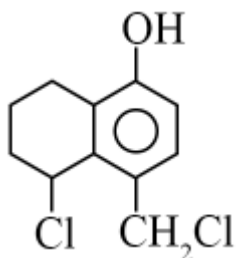
- (a)



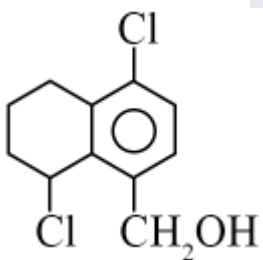
(b)



(c)



(d)



Answer: (c)

Solution: Allylic position is reactive for nucleophilic substitution reaction

Question: False statement about Calgon is:

Options:

- (a) Calgon is also called as graham's salt
- (b) Calgon method does not precipitate Ca^{2+}
- (c) Calgon contains metal which is 2nd most abundant in earth's crust
- (d) Calgon is polymeric and water soluble

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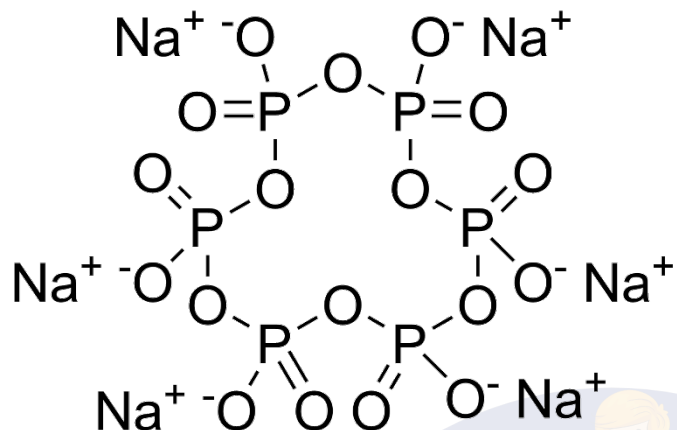
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Answer: (c)

Solution:

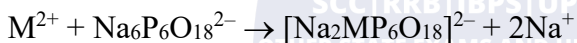
* Calgon (Sodium hexametaphosphate) is also known as Graham's salt. It has a polymeric chain structure and is water soluble



* When added to hard water, the following reaction takes place



Calgon

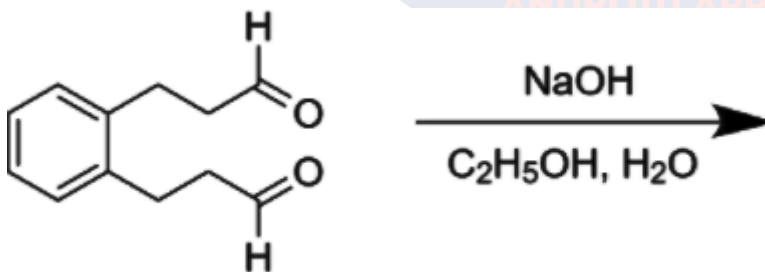


(M = Mg, Ca)

The complex ion keeps the Mg²⁺ and Ca²⁺ ion in the solution and not precipitated

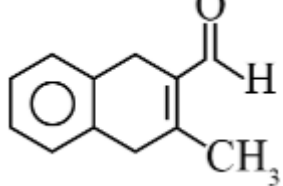
* Second most abundant metal in earth's crust is iron and is not present in Calgon

Question: Final product of the reaction is

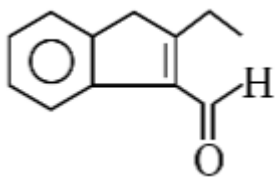


Options:

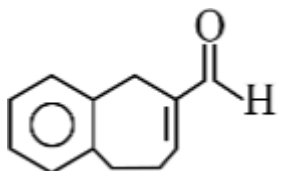
(a)



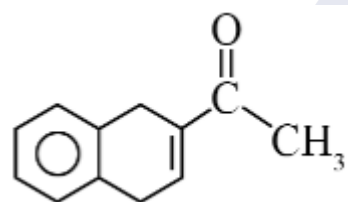
(b)



(c)



(d)



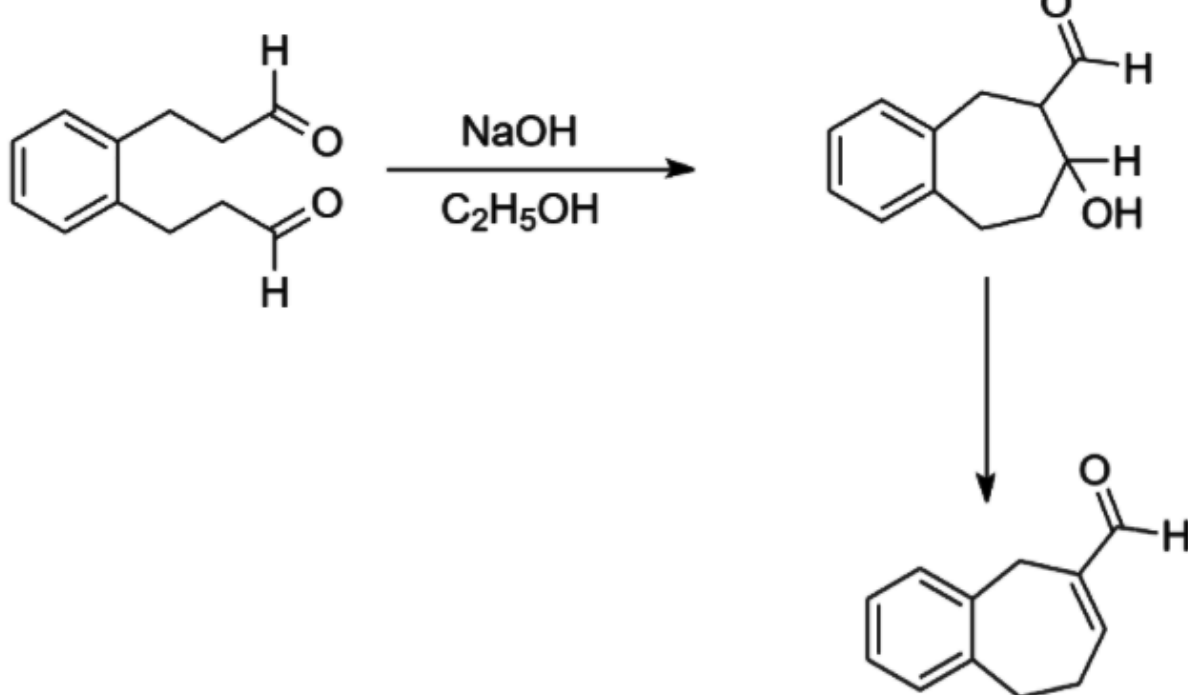
Answer: (c)

Solution:

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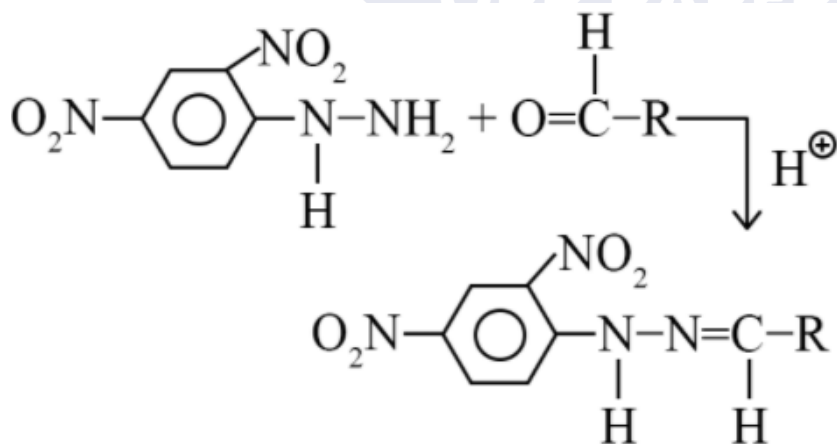
Question: 2,4 DNP test is given by:

Options:

- (a) Aldehyde
- (b) Amine
- (c) Ester
- (d) Halogens

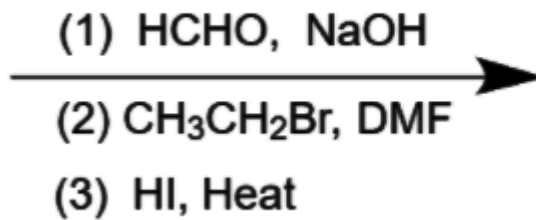
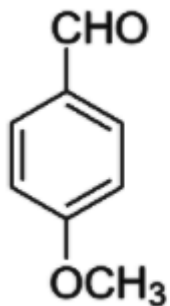
Answer: (a)

Solution:



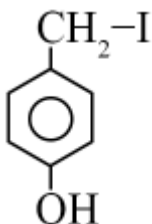
Both aldehyde and ketones gives the 2,4 DNP test

Question:

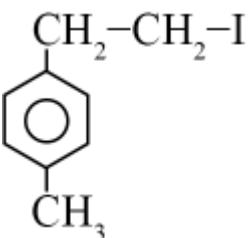


Options:

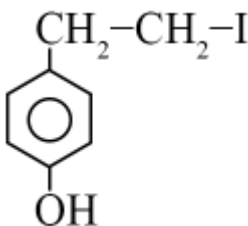
(a)



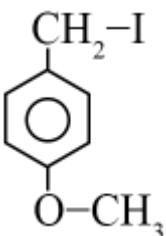
(b)



(c)



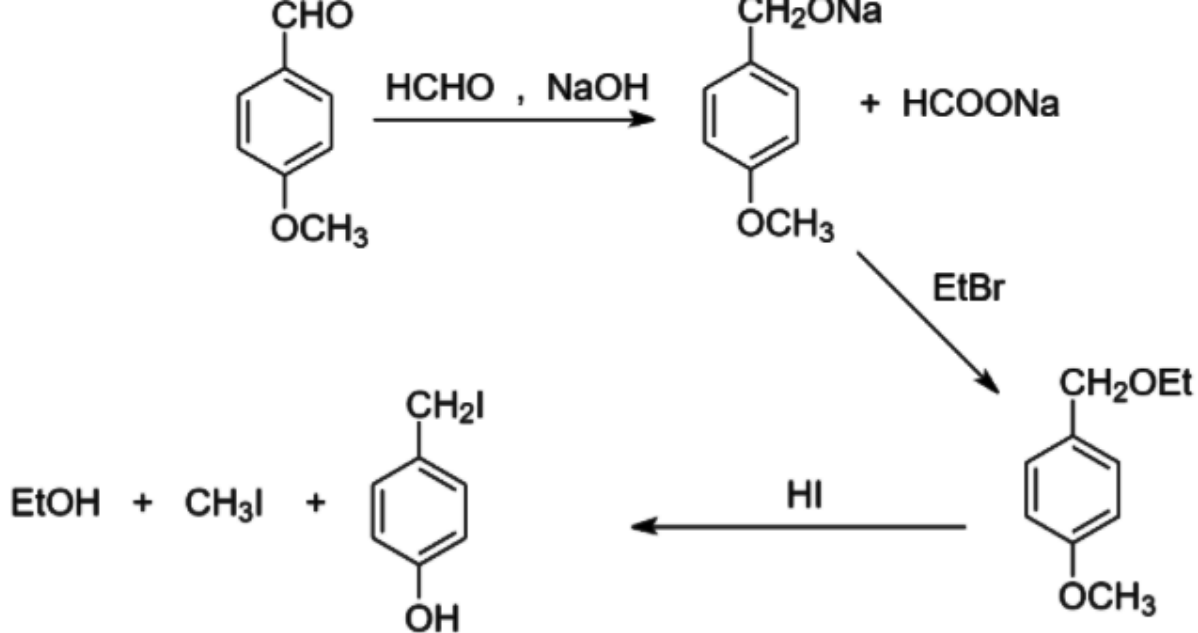
(d)



Answer: (a)

Solution:

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Question: Match the following:

Column-I	Column-II
(A) Sodium carbonate	(P) Deacon
(B) Titanium	(Q) Castner-kellner
(C) Chlorine	(R) Van-arket
(D) Sodium Hydroxide	(S) Solvay

Options:

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

Answer: (c)

Solution:

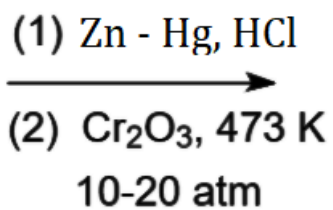
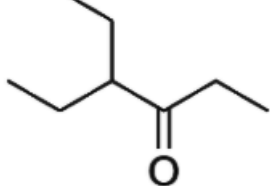
Sodium carbonate is manufactured by Solvay process.

Titanium is refined by Van-Arkle method.

Chlorine is manufactured by Deacon's process.

Sodium hydroxide is manufactured by Castner-kellner process.

Question:

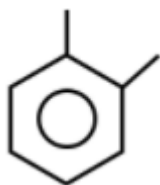


Options:

(a)



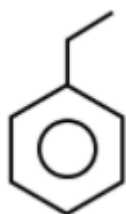
(b)



(c)



(d)



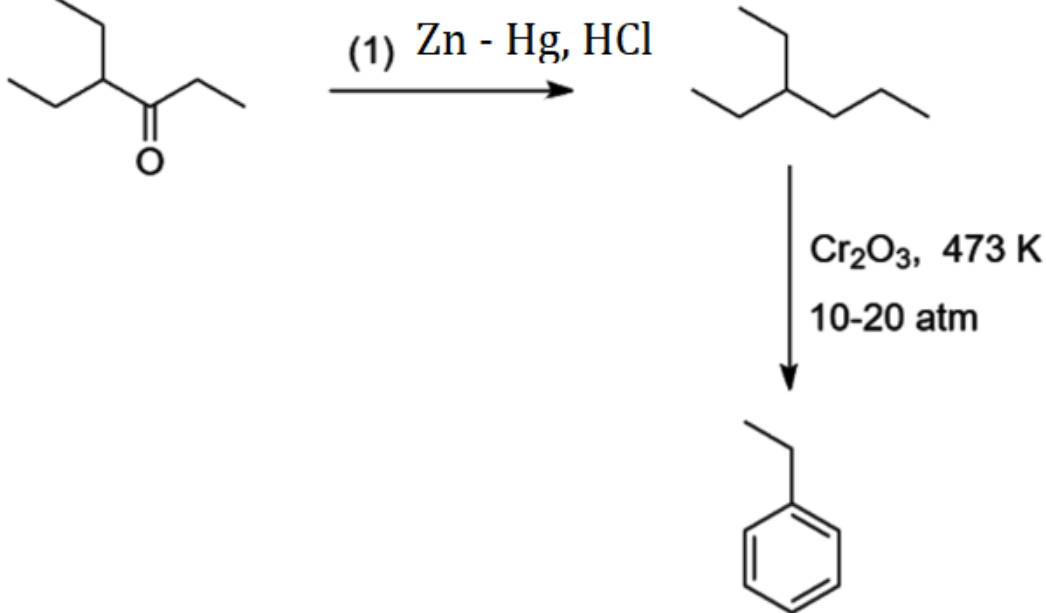
Answer: (d)

Solution:

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Question: Match the following.

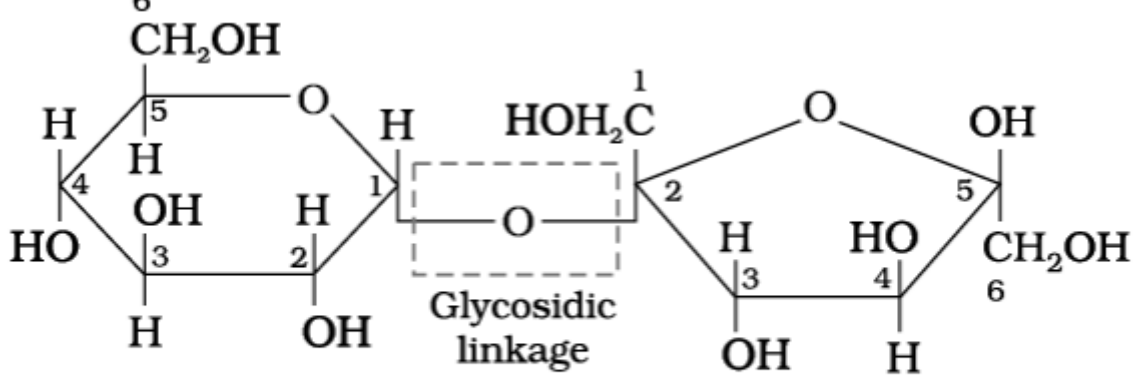
Column-I	Column-II
(A) Sucrose	(P) α -D glucose and β -D fructose
(B) Lactose	(Q) β -D galactose and β -D glucose
(C) Maltose	(R) α -D glucose and α -D glucose
(D) Cellulose	(S) β -D glucose and β -D glucose

Options:

- (a) A \rightarrow P; B \rightarrow Q; C \rightarrow R; D \rightarrow S
 (b) A \rightarrow Q; B \rightarrow R; C \rightarrow S; D \rightarrow P
 (c) A \rightarrow R; B \rightarrow S; C \rightarrow P; D \rightarrow Q
 (d) A \rightarrow S; B \rightarrow P; C \rightarrow Q; D \rightarrow R

Answer: (a)

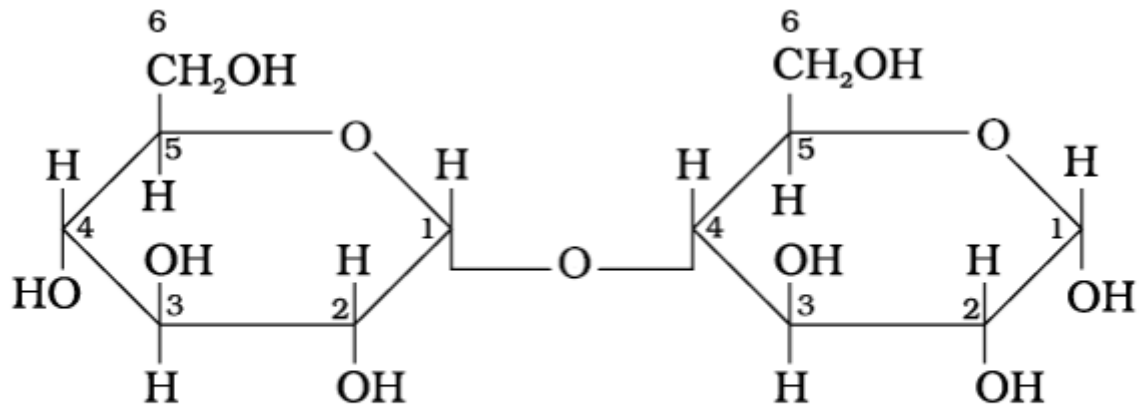
Solution:



α - D - Glucose

β - D - Fructose

Sucrose



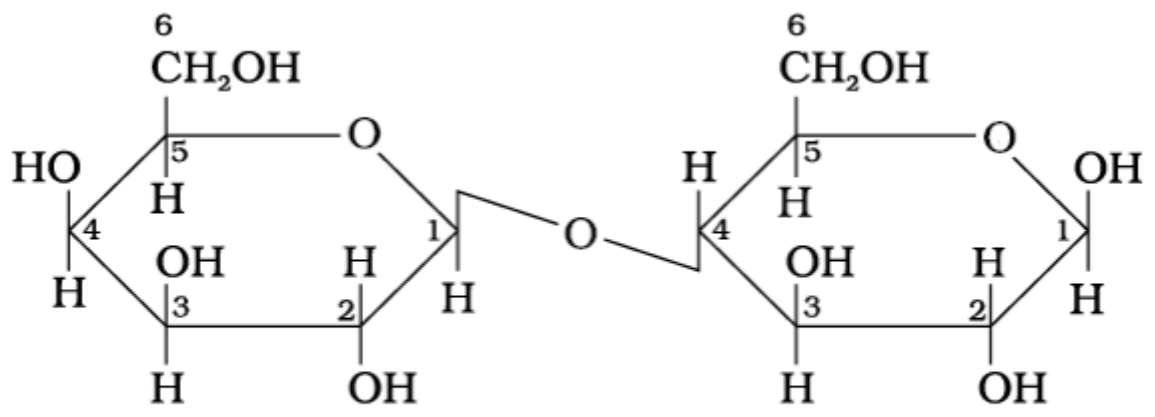
(I)

α - D - Glucose

(II)

α - D - Glucose

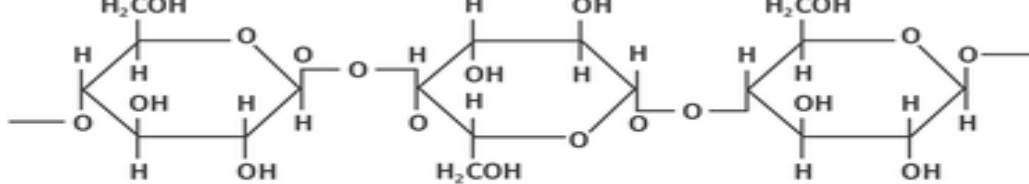
Maltose



β - D - Galactose

β - D - Glucose

Lactose



Cellulose

Question: Seliwanoff and Xanthoproteic test are respectively used for the identification of:
Options:

- (a) Proteins, Ketoses
- (b) Ketoses, Proteins
- (c) Aldoses, Ketoses
- (d) Ketoses, Aldoses

Answer: (b)

Solution:

- 1) Seliwanoff test is for carbohydrate. It distinguishes between aldoses and ketose sugar
- 2) Xanthoproteic test is for protein

Question: What is the ratio of number of octahedral voids per unit cell in HCP/CCP?

Answer: 1.50

Solution: The number of octahedral voids is equal to effective number of atoms in both HCP and CCP structures

Thus,

number of octahedral voids in HCP = 6

number of octahedral voids in CCP = 4

$$\text{Ratio} = \frac{6}{4} = 1.5$$

MATHEMATICS

Question: $\tan^{-1} a + \tan^{-1} b = \frac{\pi}{4}$.

Find the value of $a + b - \left(\frac{a^2 + b^2}{2}\right) + \left(\frac{a^3 + b^3}{3}\right) - \left(\frac{a^4 + b^4}{5}\right) \dots$

Options:

- (a)
- (b)
- (c)
- (d)

Answer: (b)

Solution:

$$\tan^{-1} a + \tan^{-1} b = \frac{\pi}{4}$$

$$\tan^{-1} \left[\frac{a+b}{1-ab} \right] = \frac{\pi}{4}$$

At $b = 1 - ab$

$$(1+a)(1+b) = 2$$

Now, $(a+b) - \left(\frac{a^2 + b^2}{2}\right) + \left(\frac{a^3 + b^3}{3}\right) - \left(\frac{a^4 + b^4}{5}\right) + \dots$

$$= \left(a - \frac{a^2}{2} + \frac{a^3}{3} - \frac{a^4}{4} + \dots \right) + \left(b - \frac{b^2}{2} + \frac{b^3}{3} - \frac{b^4}{4} + \dots \right)$$

$$= \log(1+a) + \log(1+b)$$

$$= \log(1+a)(1+b)$$

$$= \log 2$$

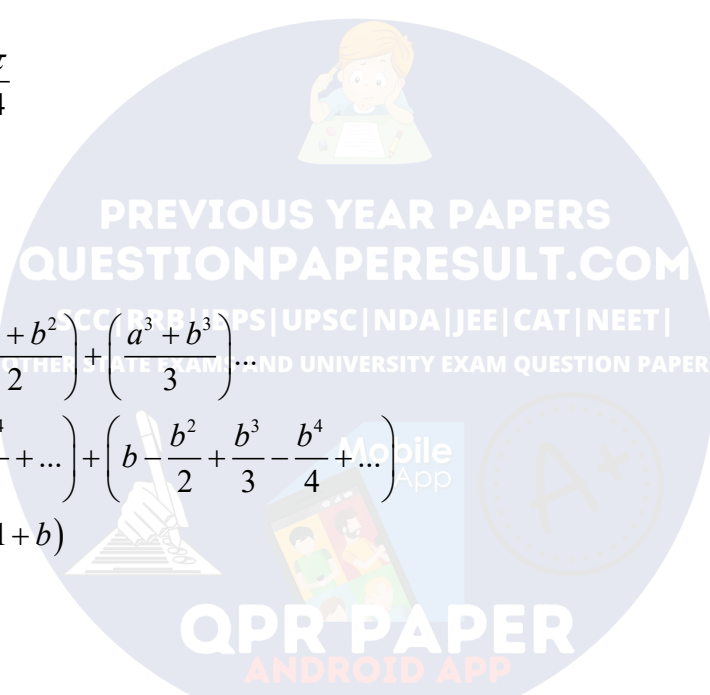
Question: 3, 3, 4, 4, 4, 5, 5 find the probability for 7 digit number such that number is divisible by 2

Options:

- (a) $\frac{1}{7}$
- (b) $\frac{3}{7}$
- (c) $\frac{4}{7}$
- (d) $\frac{6}{7}$

Answer: (b)

Solution:



Numbers given are 5, 5, 4, 4, 4, 5, 5

Total number of 7 digit number is $\frac{7!}{2!.3!.2!} = 210$

Number divisible by '2' has '4' at unit place

\therefore Total favourable case = $\frac{1 \times 66}{2!.2!.2!} = 90$

\therefore Required probability = $\frac{90}{210} = \frac{3}{7}$

Question: Mirror image of (1, 3, 5) w.r.t plane $4x - 5y + 2z = 8$ is (α, β, γ) , then

$5(\alpha + \beta + \gamma) = ?$

Options:

- (a)
- (b)
- (c)
- (d)

Answer: (c)

Solution:

Equation of line perpendicular to plane $4x - 5y + 2z = 8$ and passing through (1, 3, 5) is

$$\frac{x-1}{4} = \frac{y-3}{-5} = \frac{z-5}{2} = \lambda$$

Any general point on this line is $P(4\lambda + 1, 3 - 5\lambda, 2\lambda + 5)$

Let P lies on plane,

$$\therefore 4(4\lambda + 1) - 5(-5\lambda + 3) + 2(2\lambda + 5) = 8$$

$$45\lambda = 9$$

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

$$\therefore P = \left(\frac{9}{5}, 2, \frac{27}{5} \right)$$

As P is mid point of (1, 3, 5) and (α, β, γ)

$$\therefore \alpha = \frac{13}{5}, \beta = 1, \gamma = \frac{29}{5}$$

$$\alpha + \beta + \gamma = \frac{47}{5}$$

$$5(\alpha + \beta + \gamma) = 47$$

Question: $f(x)$ is differentiable function at $x = a$, such that $f'(a) = 2$, $f(a) = 4$. Find

$$\lim_{x \rightarrow a} \frac{xf(a) - af(x)}{x - a}$$

Options:

- (a)
- (b)
- (c)
- (d)

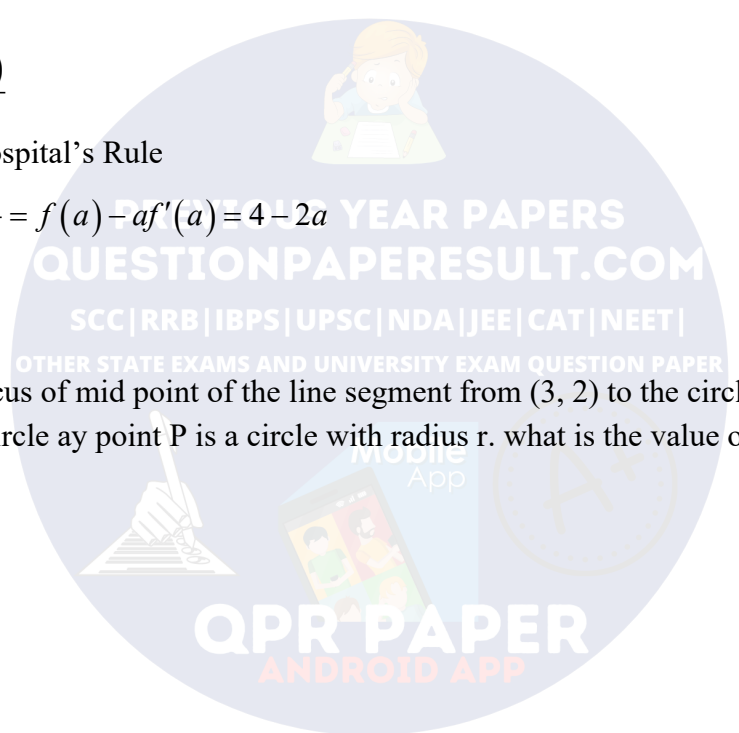
Answer: (0)

Solution:

$$\lim_{x \rightarrow a} \frac{xf(a) - af(x)}{x - a}$$

On applying L-Hospital's Rule

$$\lim_{x \rightarrow a} \frac{f(a) - af'(x)}{1} = f(a) - af'(a) = 4 - 2a$$



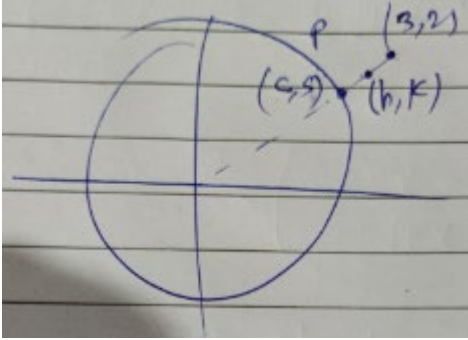
Question: The locus of mid point of the line segment from $(3, 2)$ to the circle $x^2 + y^2 = 1$ which touch the circle at point P is a circle with radius r. what is the value of r

Options:

- (a) 1
- (b) $\frac{1}{2}$
- (c) $\frac{1}{3}$
- (d) $\frac{1}{4}$

Answer: (b)

Solution:



$$\frac{c+3}{2}, \frac{2+5}{2}$$

$$h = \frac{c+3}{2}, k = \frac{2+5}{2}$$

$$2h - 3 = c, 2k - 2 = 5$$

$$4h^2 + 9 - 12h + 4k^2 + 4 - 8k = 1$$

$$h^2 + k^2 + \frac{9}{4} - 3h - 2k + 1 - \frac{1}{4} = 0$$

$$r = \sqrt{9 + 1 - \frac{9}{4} - 1 + \frac{1}{4}}$$

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

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Question: The slope of the tangent to curve is $\frac{xy^2 + y}{x}$ and it intersects the line $x + 2y = 4$ at

$x = -2$, then the value of 'y' is (3, y) lies on the curve?

Options:

- (a)
- (b)
- (c)
- (d)

Answer: ()

Solution:

$$\frac{dy}{dx} = \frac{xy^2 + y}{x} \Rightarrow \frac{dy}{dx} - \frac{y}{x} = y^2$$

$$\frac{1}{y^2} \frac{dy}{dx} - \frac{1}{yx} = 1$$

$$\text{Put } -\frac{1}{y} = t \Rightarrow \frac{1}{y^2} \frac{dy}{dx} = \frac{dt}{dx}$$

$$\Rightarrow \frac{dt}{dx} + \frac{t}{x} = 1$$

$$I.F. = e^{\int \frac{dx}{x}} = \ln x = x$$

$$\therefore t(x) = \int x dx = \frac{x^2}{2} + C$$

$$\Rightarrow \frac{-x}{y} = \frac{x^2}{2} + C \text{ (passes through (3, y))}$$

$$\Rightarrow -\frac{3}{y} = \frac{9}{2} + C \Rightarrow -\frac{3}{y} - \frac{9}{2}$$

$$\Rightarrow -\frac{x}{y} = \frac{x^2}{2} - \frac{9}{2} - \frac{3}{y}$$

$$\Rightarrow \frac{3-x}{y} = \frac{x^2-9}{2}$$

$$\Rightarrow y = \frac{2(3-x)}{x^2-9}$$

$$\text{At } x = -2; y = \frac{2 \times 5}{(-5)} = -2$$

Question: $f(x) = \int_1^x \frac{\ln(1+t)}{t} dt, f(e) + f\left(\frac{1}{e}\right) = ?$

Options:

- (a)
- (b)
- (c)
- (d)

Answer: 0

Solution:

$$f(x) = \int_1^x \frac{\ln(1+t)}{t} dt : f\left(\frac{1}{x}\right) = \int_1^{\frac{1}{x}} \frac{\ln(1+t)}{t} dt$$

$$\text{Let } t = \frac{1}{u} \Rightarrow dt = -\frac{1}{u^2} du$$

$$\therefore f\left(\frac{1}{x}\right) = \int_1^x \frac{\ln\left(1+\frac{1}{u}\right)}{\left(\frac{1}{u}\right)} \left(-\frac{1}{u^2}\right) du = -\int_1^x \frac{\ln\left(\frac{1+u}{u}\right)}{u} du$$

$$\therefore f(x) + f\left(\frac{1}{x}\right) = \int_1^x \left[\frac{\ln(1+t)}{t} - \frac{\ln(1+t)}{t} + \frac{\ln t}{t} \right] dt$$

$$f(x) + f\left(\frac{1}{x}\right) = \int_1^x \frac{\ln t}{t} dt = \left[\frac{(\ln t)^2}{2} \right]_1^x = \frac{1}{2} \ln^2 x$$

$$\therefore f(e) + f\left(\frac{1}{e}\right) = \frac{1}{2} \ln^2 e = \frac{1}{2}$$

Question: $f(x) = \int_1^x e^t f(t) dt + e^x$; $f(x)$ is a differentiable function $x \in R$. Then $f(x) =$

Options:

- (a)
- (b)
- (c)
- (d)

Answer: (c)

Solution:

$$f(x) = \int_1^x e^t f(t) dt + e^x$$

$$f'(x) = e^x f(x) + e^x$$

$$\frac{dy}{dx} = e^x (y+1)$$

$$\int \frac{dy}{(y+1)} = \int e^x dx$$

$$\log|y+1| = e^x + C$$

$$y+1 = \pm e^C e^{e^x}$$

$$y+1 = k \cdot e^{e^x} \quad (\text{Put } \pm e^C = k)$$

$$\text{At } x=1, y=0$$

$$\Rightarrow 1 = k e^e$$

$$k = \frac{1}{e^e}$$

$$\Rightarrow y+1 = \frac{e^{e^x}}{e^e}$$

$$\Rightarrow f(x) = \frac{e^{e^x} - 1}{e^e}$$

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Question: If A_1 is area between the curves $y = \sin x$, $y = \cos x$ and y -axis for $0 \leq x \leq \frac{\pi}{2}$ and

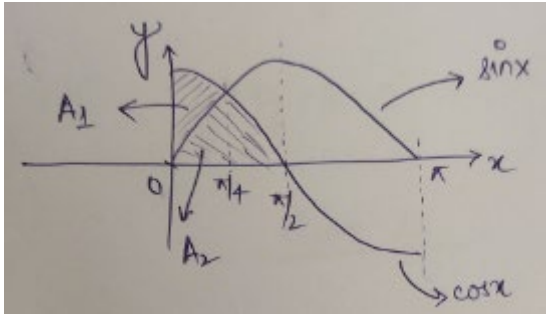
A_2 is area between $y = \sin x$ and $y = \cos x$ and x -axis for $0 \leq x \leq \frac{\pi}{2}$, the find $\frac{A_2}{A_1}$

Options:

- (a)
- (b)
- (c)
- (d)

Answer: (c)

Solution:



$$A_1 = \int_0^{\frac{\pi}{4}} (\cos x - \sin x) dx = (\sin x + \cos x) \Big|_0^{\frac{\pi}{4}} = \sqrt{2} - 1$$

$$A_2 = \int_0^{\frac{\pi}{4}} \sin x dx + \int_{\frac{\pi}{4}}^{\frac{\pi}{2}} \cos x dx = (-\cos x) \Big|_0^{\frac{\pi}{4}} + (\sin x) \Big|_{\frac{\pi}{4}}^{\frac{\pi}{2}}$$

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

$$\frac{A_2}{A_1} = \frac{2 - \sqrt{2}}{\sqrt{2} - 1} = \sqrt{2}$$

Question: $P_n = \alpha^n + \beta^n$, $\alpha + \beta = 1$, $\alpha\beta = -1$, $P_{n-1} = 11$, $P_{(n+1)} = 29$, then $(P_n)^2$

Answer: 324.00

Solution:

$$(\alpha + \beta)P_n = (\alpha + \beta)(\alpha^n + \beta^n)$$

$$(\alpha + \beta)P_n = \alpha^{n+1} + \beta^{n+1} + \alpha\beta(\alpha^{n-1} + \beta^{n-1})$$

$$\Rightarrow (1)P_n = P_{n+1} - P_{n-1} = 29 - 11 = 18$$

$$\Rightarrow P_n^2 = 324$$

Question: Let $A(1, 4)$ and $B(1, -5)$ be the points Let P be the point on

$$(x-1)^2 + (y-1)^2 = 1. \text{ Find maximum value of } (PA)^2 + (PB)^2.$$

Answer: 53.00

Solution:

$$\text{Let } P(1 + \cos \theta, 1 + \sin \theta)$$

$$\therefore PA^2 + PB^2 = \cos^2 \theta + (\sin \theta - 3)^2 + \cos^2 \theta + (\sin \theta + 6)^2$$

$$= 2 \cos^2 \theta + 2 \sin^2 \theta + 6 \sin \theta + 45$$

$$= 47 + 6 \sin \theta$$

So, it will be maximum when $\sin \theta = 1$

$$\therefore (PA^2 + PB^2)_{\max} = 47 + 6 = 53$$

Question: Let L be a line of intersection of $x + 2y + z = 0$ and $y + z = 4$. If $P(\alpha, \beta, \gamma)$ is foot of perpendicular from $(3, 2, 1)$ on L . Find $21(\alpha + \beta + \gamma)$.

Options:

- (a)
- (b)
- (c)
- (d)

Answer: 98.00

Solution:

D.R. of line L :

$$\begin{vmatrix} i & j & k \\ 1 & 2 & 1 \\ 0 & 1 & 1 \end{vmatrix} = (1, -1, 1)$$

$$\text{Put } z = 0 \text{ in both planes } \Rightarrow y = 4, x = -2$$

$$\therefore \text{Equation of line } L \Rightarrow \frac{x+2}{1} = \frac{y+4}{-1} = \frac{z-0}{1} = \lambda$$

Let point P on line is $(\lambda - 2, 4 - \lambda, \lambda)$ & $A(3, 2, 1)$

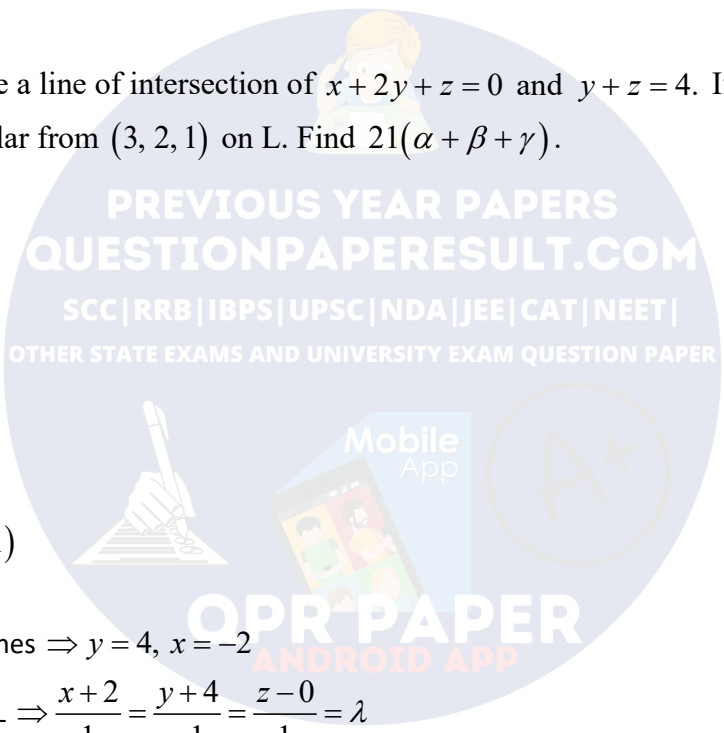
$\therefore AP \perp$ line

$$\therefore (1)(\lambda - 5) + (-1)(2 - \lambda) + (1)(\lambda - 1) = 0$$

$$\Rightarrow 3\lambda = 8 \Rightarrow \lambda = \frac{8}{3}$$

$$\Rightarrow P\left(\frac{2}{3}, \frac{4}{3}, \frac{8}{3}\right)$$

$$\Rightarrow 21(\alpha + \beta + \gamma) = 21\left(\frac{2}{3} + \frac{4}{3} + \frac{8}{3}\right)$$



$$= 21 \binom{14}{3} = 98$$

Question: How many four digit numbers are there where g.c.d. with 18 is '3'.

Options:

- (a)
- (b)
- (c)
- (d)

Answer: 1000.00

Solution:

Number of required numbers

= 4 digit numbers divisible by 3 – 4 digit numbers divisible by 6 – 4 digit numbers divisible by 9 + 4digit numbers divisible by 18

$$= 3000 - 1500 - 1000 + 200$$

$$= 1000$$

Question: The prime factorization of a number 'n' is given as $n = 2^x \times 3^y \times 5^z$, $y + z = 5$ and

$y^{-1} + z^{-1} = \frac{5}{6}$. Find out the odd divisors of n including 1

Answer: 12.00

Solution:

$$y + z = 5 : \frac{1}{y} + \frac{1}{z} = \frac{5}{6} \Rightarrow (y, z) = (2, 3) \text{ or } (3, 2)$$

\therefore Number of odd divisors of $n = 2^x \cdot 3^y \cdot 5^z$ is $(y+1)(z+1)$

$$= 3 \times 4 = 12$$

Question: -16, 8, -4, 2,, A.M and G.M of p^{th} and q^{th} terms are roots of $4x^2 - 9x + 5 = 0$ then $p + q =$

Answer: 10.00

Solution:

Given sequence is -16, 8, -4, 2

It is a GP with common ratio $r = -\frac{1}{2}$

Its n^{th} term is $a_n = (-16) \left(-\frac{1}{2}\right)^{n-1}$

Roots of $4x^2 - 9x + 5 = 0$ are $1, \frac{5}{4}$

$\therefore GM \leq AM \Rightarrow \therefore GM = 1$

Now GM of p^{th} and q^{th} term = $\sqrt{(-16)\left(-\frac{1}{2}\right)^{p-1} \cdot (-16)\left(-\frac{1}{2}\right)^{q-1}}$

$$\Rightarrow 16\left(-\frac{1}{2}\right)^{\frac{p+q-2}{2}} = 1$$

$$\Rightarrow \left(-\frac{1}{2}\right)^{\frac{p+q-2}{2}} = \frac{1}{16}$$

$$\Rightarrow \frac{p+q-2}{2} = 4$$

$$\Rightarrow p+q=10$$

Question: The value of square of slope of the common tangent to the curves $4x^2 + 9y^2 = 36$ and $(2x)^2 + (2y)^2 = 31$

Options:

- (a)
- (b)
- (c)
- (d)

Answer: 3.00

Solution:

Given ellipse are $\frac{x^2}{9} + \frac{y^2}{4} = 1$ and $\frac{x^2}{\left(\frac{31}{4}\right)} + \frac{y^2}{\left(\frac{31}{4}\right)} = 1$

Let equation of common tangent to ellipse with slope 'm' is

$$y = mx + \sqrt{9m^2 + 4} \quad \text{and} \quad y = mx + \sqrt{\frac{31}{4}m^2 + \frac{31}{4}}$$

$$\therefore 9m^2 + 4 = \frac{31}{4}m^2 + \frac{31}{4}$$

$$\Rightarrow \frac{5m^2}{4} = \frac{15}{4}$$

$$\Rightarrow m^2 = 3$$

Question: $\sum_{n=1}^{18} (x_i - \alpha) = 36$; $\sum_{n=1}^{18} (x_i - \beta)^2 = 90$ and the standard deviation is

Find $|\beta - \alpha|$

Answer: 0.00

Solution:

Let $\alpha = \beta$

∴ Standard deviation remains unchanged if observations are added or subtracted by a fixed number

$$\therefore S.D. = \sqrt{\frac{\sum_{i=1}^{18} (x_i - \alpha)^2}{18} - \left[\frac{\sum_{i=1}^{18} (x_i - \alpha)}{18} \right]^2}$$

$$= \sqrt{\left(\frac{90}{18}\right) - \left(\frac{36}{18}\right)^2} = 1, \text{ which is given}$$

Hence, $\alpha = \beta$ according to the conditions

$$\therefore |\beta - \alpha| = 0$$

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