PHYSICS

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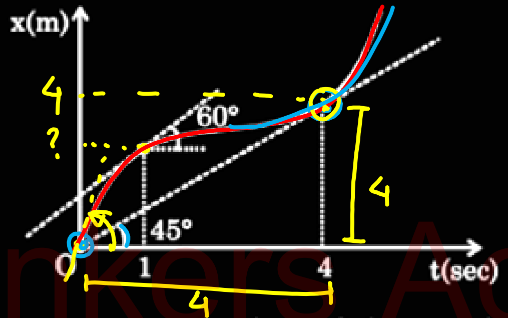
Straight line motion of a particle along x-axis is represented by the following position (x) – time (t) graph. Then :-

$\boxed{\text{Slope}_{x-t} = v}$

$\cancel{x = t^2}$, $\cancel{v = 2t}$, $\cancel{\boxed{a = 2}}$



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X (A) Average velocity of the particle from t = 0 to t = 1sec is $\sqrt{3}$ m/s. $= \frac{?}{T}$

X (B) Velocity of the particle at t = 0 is 1 m/s. X

X (C) Acceleration of the particle at t = 4sec is 1 m/s^2. ??

✓ (D) Average velocity of the particle from t = 0 to t = 4sec is 1 m/s. $= \frac{S}{T} = \frac{4}{4} = 1\,m/s$

2

The height $\boxed{h}$ at which the weight of a body will be the same as that at the same depth $\boxed{h}$ from the surface of the earth is (Radius of the earth is R and effect of the rotation of the earth is neglected) $\boxed{h=?}$

$W = mg$

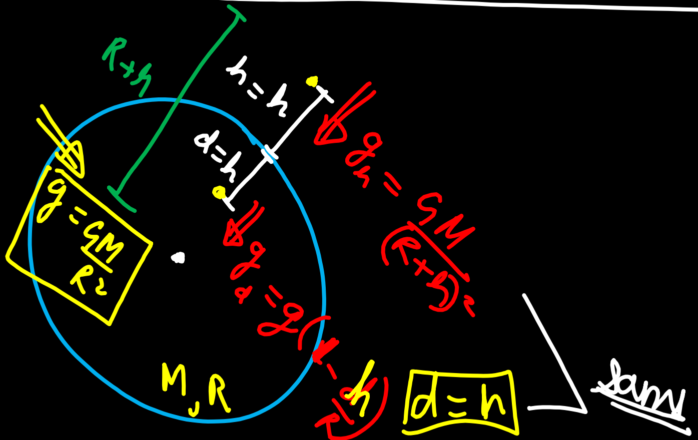
$R=1$

(A) $\frac{R}{2} = h = \frac{1}{2}$

(B) $\frac{\sqrt{5}}{2}R - R = h$ $\frac{\sqrt{5}}{2} - 1$

(C) $\frac{\sqrt{3R}-R}{2} = h = \frac{\sqrt{2}}{2}$

(D) $\frac{\sqrt{5}R-R}{2} = h$ $\frac{\sqrt{5}-1}{2}$



$$g_{h=h} = g_{d=h}$$

$$\frac{GM}{(R+h)^2} = \boxed{g}\left(1 - \frac{h}{R}\right)$$

$$\frac{\cancel{GM}}{(R+h)^2} = \frac{\cancel{GM}}{R^2}\left(\frac{R-h}{R}\right)$$

$$R^3 = (R^2+h^2+2Rh)(R-h)$$

$$\cancel{R^3} = \cancel{R^3} + h^2R + 2R^2h - R^2h - h^3 - 2Rh^2$$

$$\boxed{R=1}$$

$$(1+h^2+2h)(1-h) = 1$$

$$-\cancel{h}(h^2+h-1) = 0$$

$$h = \frac{-1 \pm \sqrt{5}}{2} = \frac{\sqrt{5}-1}{2}$$

JEE 1
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3

N moles of a diatomic gas in a cylinder are at a temperature T. Heat is supplied to the cylinder such that the temperature remains constant but n moles of the diatomic gas get converted into monoatomic gas. What is the change in the total kinetic energy of the gas?

(A) 0 (B) $\frac{5}{2}$nRT

(C) $\frac{1}{2}$nRT (D) $\frac{3}{2}$nRT

$PV = nRT = NkT$

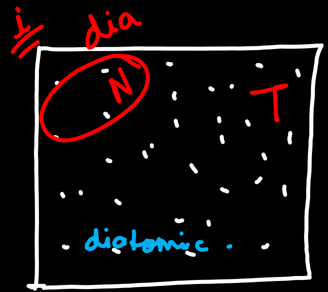
$k = \frac{R}{N_A}$

$\boxed{KE_{gas} = \frac{f}{2} nRT}$

$f_{mono} = 3$

$f_{dia} = 5$

$\Delta KE = KE_f - KE_i$



$KE_i = \frac{5}{2} NRT$

$KE_f = \frac{5}{2}(N-n)RT + \frac{3}{2}(2n)RT$

Ans

$\Delta KE = \frac{5}{2}(\cancel{N}-n)RT + 3nRT - \cancel{\frac{5}{2}NRT}$

$\boxed{\Delta KE = \frac{1}{2}nRT}$

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Match List-I with List-II.

List-I	List-II
(A) Torque	(i) MLT^{-1}
(B) Impulse	(ii) MT^{-2}
(C) Tension	(iii) $ML^2 T^{-2}$
(D) Surface tension	(iv) MLT^{-2}

~~(A) (A)-(iii); (B)-(iv); (C)-(i); (D)-(ii)~~

(B) (A)-(iii); (B)-(i); (C)-(iv); (D)-(ii)

~~(C) (A)-(i); (B)-(iii); (C)-(iv); (D)-(ii)~~

~~(D) (A)-(ii); (B)-(i); (C)-(iv); (D)-(iii)~~

$[\tau] = [r][F_\perp] = L\, MLT^{-2}$

$[\tau] = ML^2 T^{-2}$

$[J] = [F][T] = MLT^{-2} \cdot T$

$= MLT^{-1}$

force.

$[T] = MLT^{-2}$

$[T_s] = \dfrac{[F]}{[L]} = \dfrac{M\cancel{L}T^{-2}}{\cancel{L}}$

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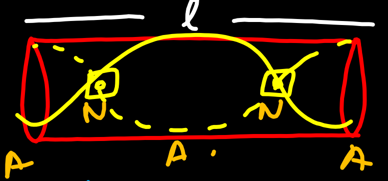
5

The first overtone frequency of an open organ pipe is equal to the fundamental frequency of a closed organ pipe. If the length of the closed organ pipe is 20 cm. The length of the open organ pipe is_______ cm.

(A) 20 (B) 80

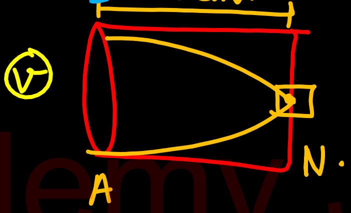
(C) 70 (D) 60

$l = ?$



$f = \frac{V}{l}$

$l_2 = 20\,cm$



$f = \frac{V}{4l_2}$

same.

open. $\frac{V}{2l}, \frac{2V}{2l}, \frac{3V}{2l}$

I overtone

closed $\frac{V}{4l}, \frac{3V}{4l}, \frac{5V}{4l}$

$\frac{\cancel{V}}{l} = \frac{\cancel{V}}{4l_2}$

$l = 4l_2 = 80\,cm$

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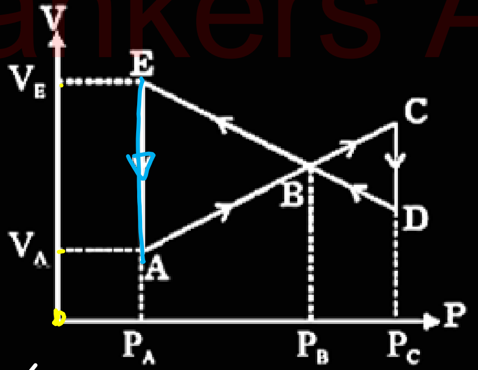
6

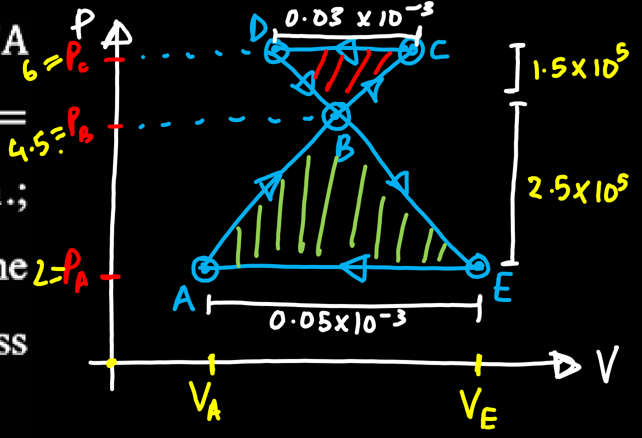
S.I.

Figure shows a cyclic process ABCDBEA performed on an ideal gas. If $P_A = 2$ atm., $P_B = 4.5$ atm. and $P_C = 6$ atm.; $V_E - V_A = 0.05$ litre, find the work done by the gas (in J) in the complete process in nearest integer.

(1 atm. pressure $= 1 \times 10^5$ Pa)

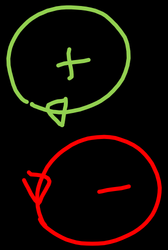


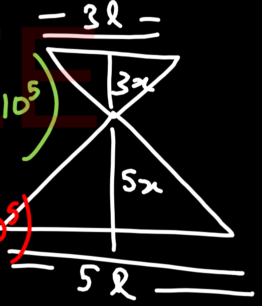
(A) 4
(B) 8
(C) 2
(D) 2/5



JEE 1

$1 m^3 = 1000\ \ell$





$$\text{Ans} = W = \left(\frac{1}{2} \times 0.05 \times 10^{-3} \times 2.5 \times 10^5\right) - \left(\frac{1}{2} \times 0.03 \times 10^{-3} \times 1.5 \times 10^5\right)$$

$$= \frac{12.5}{2} - \frac{4.5}{2} = 4\ J$$

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7

Young's moduli of two wires A and B are in the ratio 7 : 4. Wire A is 2 m long and has radius R. Wire B is 1.5 m long and has radius 2 mm. If the two wires stretch by the same length for a given load, then the value of R is close to

(A) 1.9 mm (B) 1.5 mm

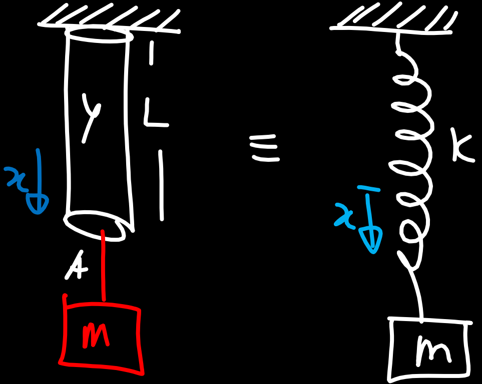
(C) 1.3 mm (D) 1.7 mm

$R_1 =$ R, $R_2 =$ 2 mm

$\boxed{\frac{Y_1}{Y_2} = \frac{7}{4}}$

$\boxed{\frac{L_1}{L_2} = \frac{2}{3/2} = \frac{4}{3}}$

$R_1 = ?$



$\equiv$

$K = \frac{YA}{L}$

same $x = \frac{mg}{K}$ same

$K_1 = K_2$

$\frac{Y_1 A_1}{L_1} = \frac{Y_2 A_2}{L_2}$

$\left(\frac{Y_1}{Y_2}\right) \frac{\cancel{\pi} R_1^2}{\cancel{\pi} R_2^2} = \left(\frac{L_1}{L_2}\right)$

$\frac{7}{4}\left(\frac{R_1}{R_2}\right)^2 = \frac{4}{3}$

$R_1 = \sqrt{\frac{16}{21}} \cdot \boxed{R_2}$

$\boxed{\sqrt{\frac{16}{21}} \cdot 2\,\text{mm}}$

4 5

$\sqrt{16}$ $\sqrt{21}$ $\sqrt{25}$

$\frac{8}{\sqrt{21}}$

$\frac{8}{4.5} = \frac{8 \times 2}{9} \quad \frac{16}{9}$

Ice at $-20°C$ is added to 50 g of water at 40°C. When the temperature of the mixture reaches 0°C, it is found that 20 g of ice is still unmelted. The amount of ice added to the water was close to (Specific heat of water = 4.2 J/g/°C Specific heat of Ice = 2.1 J/g Heat of fusion of water at 0°C = 334J/g)

(A) 60 g (B) 50 g

(C) 40 g (D) 100 g

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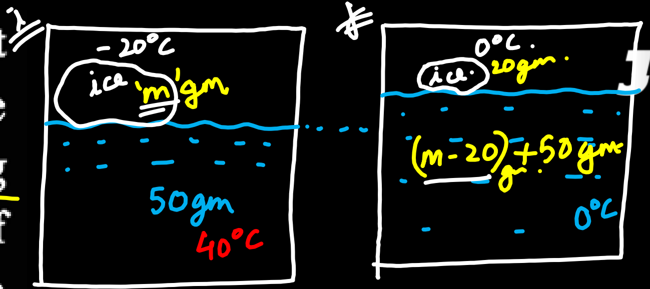
$$Q = m s \Delta T$$
$$Q = m L$$

J

gm

°C



Heat Gained = Heat Lost

$$m(2.1)(20) + (m-20)334 = 50(4.2)(40)$$

$$\boxed{m = 40.1\ gm}$$

9

A juggler throws balls vertically upwards with same initial velocity in air. When the first ball reaches its highest position, he throws the next ball. Assuming the juggler throws n balls per second, the maximum height the balls can reach is

$n = 2$

(A) $g/2n = g/4$ (B) $g/n = g/2$

(C) $2gn = 4g$ (D) $g/2n^2 = g/8$

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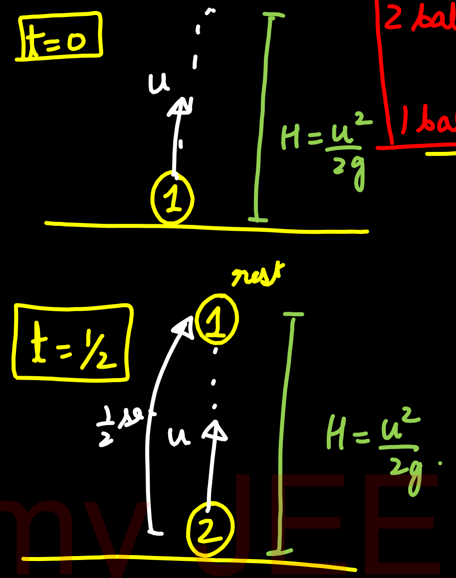
2 ball — 1 sec.

1 ball — 0.5 sec



$T = 1 = \frac{2u}{g}$

$\boxed{u = g/2}$

$\text{Ans} = H = \frac{u^2}{2g}$

$= \frac{g}{8}$

10

JEE 1

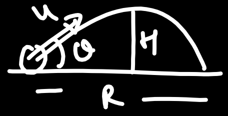
Let the maximum horizontal range a particle can achieve with an initial speed u is $\boxed{R}$ for ground to ground projection. If a particle is projected with speed u, has a horizontal range $\boxed{\frac{3R}{5}}$ then difference in the maximum heights attained in the two cases is $\boxed{\frac{R}{n}}$, then find the value of n.

45°

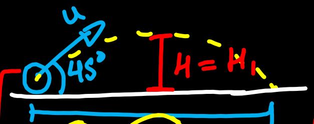
$H_1 - H_2 = \frac{R}{n}$

(A) 4 (B) 5

(C) 3 (D) 1



$$\boxed{\frac{R}{H} = \frac{4}{\tan\theta}}$$



$$R = \frac{u^2}{g}(1)$$

$$\frac{R}{H_1} = \frac{4}{1}$$

$$\boxed{H_1 = \frac{R}{4}}$$

$$R_2 = \frac{u^2}{g}\sin(2\theta) = \frac{3R}{5}$$

$$\frac{u^2}{g}\sin(2\theta) = \frac{3}{5}\frac{u^2}{g}$$

$$\boxed{\sin(2\theta) = \frac{3}{5}}$$

$$\boxed{2\theta = 37^\circ}$$

$$\frac{R_2}{H_2} = \frac{4}{\tan\theta}$$

$$\boxed{H_2 = \frac{\frac{3R}{5}}{4} \cdot \tan\theta}$$

$$\boxed{H_2 = \frac{3R}{20} \times \frac{1}{3} = \frac{R}{20}}$$

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

37°

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

$$\frac{4}{5} = \frac{1 - t^2}{1 + t^2}$$

$$4 + 4t^2 = 5 - 5t^2$$

$$9t^2 = 1$$

$$\boxed{t = 1/3}$$

$$\text{Ans} = H_1 - H_2 = \frac{R}{4} - \frac{R}{20}$$

$$= \frac{R}{5} = \frac{R}{n}$$

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11

JEE 1

If the potential energy between two molecules is given by $\boxed{U = -\frac{A}{r^6} + \frac{B}{r^{12}}}$, then at equilibrium, separation between molecules, and the potential energy are

$F = 0 = -\frac{dU}{dr}$

(A) $\left(\frac{B}{2A}\right)^{1/6}, -\frac{A^2}{2B}$ (B) $\left(\frac{B}{A}\right)^{1/6}, 0$

(C) $\left(\frac{2B}{A}\right)^{1/6}, -\frac{A^2}{4B}$ (D) $\left(\frac{2B}{A}\right)^{1/6}, -\frac{A^2}{2B}$

$r\Big|_{F=0} = ?$

$U = -Ar^{-6} + Br^{-12}$

$\frac{dU}{dr} = 6Ar^{-7} - 12Br^{-13} = 0$

$\frac{6A}{12B} = \frac{r^{-13}}{r^{-7}}$

$\frac{2B}{A} = r^6$

Ans ① $\boxed{r = \left(\frac{2B}{A}\right)^{1/6}}$

Ans ② $= U\Big|_{r=\left(\frac{2B}{A}\right)^{1/6}} = -\frac{A}{\left(\frac{2B}{A}\right)} + \frac{\cancel{B}}{\frac{4B^{\cancel{2}}}{A^2}}$

$= -\frac{A^2}{2B} + \frac{A^2}{4B} = -\frac{1}{4}\frac{A^2}{B}$

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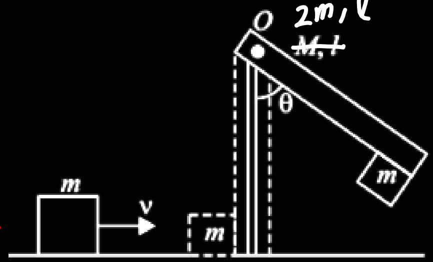
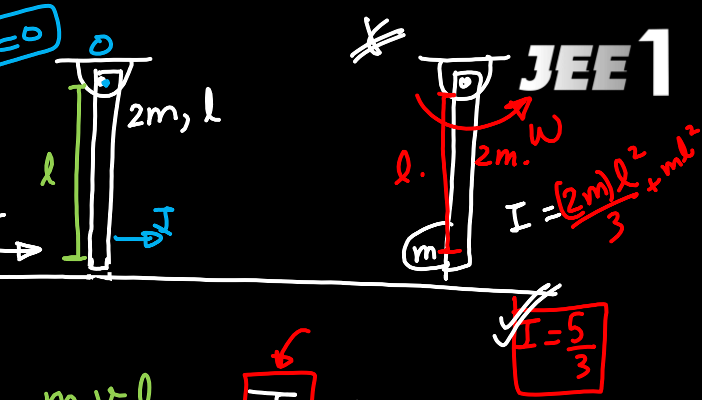
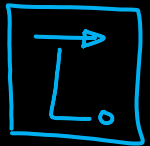
12

A block of mass m = 1 kg slides with velocity v = 6 m/s on a frictionless horizontal surface and collides with a uniform vertical rod and sticks to it as shown. The rod is pivoted about O and swings as a result of the collision making angle θ before momentarily coming to rest. If the rod has mass M = 2 kg and length l = 1 m, the value of θ is approximately (take $g = 10\ m/s^2$



(A) 63°
(B) 55°
(C) 69°
(D) 49°





$mvl = \boxed{I}\omega$

$6 = \frac{5}{3}\omega$

$\boxed{\omega = \frac{18}{5}}$

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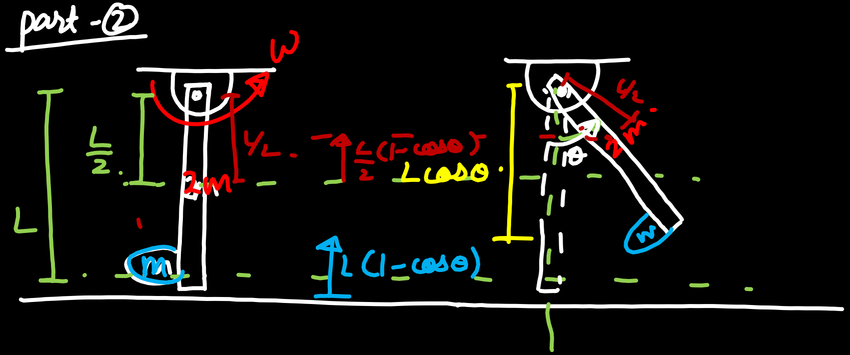
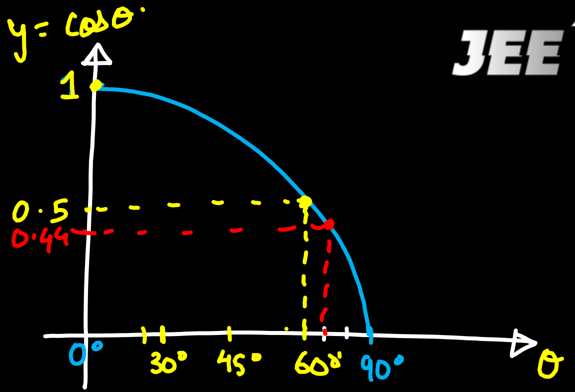
JEE 1





$\omega = \frac{18}{5}$

$I = \frac{5}{3}$

$$KE_{dec} = PE_{inc.}$$

$$\frac{1}{2} I\omega^2 = mgL(1-\cos\theta) + \cancel{2}mg\frac{L}{\cancel{2}}(1-\cos\theta)$$

$$\frac{\cancel{5}}{\cancel{6}} \times \frac{\overset{3}{\cancel{18}}\times 18}{\underset{5}{\cancel{25}}} = 20(1-\cos\theta)$$

$$\frac{54}{100} = 1-\cos\theta$$

$$\boxed{\cos\theta = \frac{44}{100}} \boxed{= 0.44}$$

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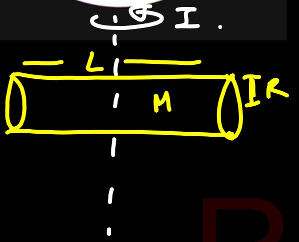
13

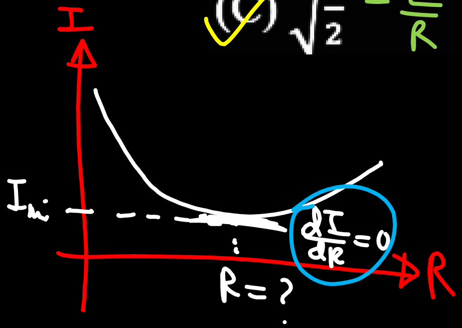
Moment of inertia of a cylinder of mass M, length L and radius R about an axis passing through its centre and perpendicular to the axis of the cylinder is $\boxed{I = M\left(\frac{R^2}{4} + \frac{L^2}{12}\right)}$. If such a cylinder is to be made for a given mass of material, the ratio L/R for it to have minimum possible I is

(A) $\sqrt{\frac{2}{3}} = \frac{L}{R}$ (B) $\frac{3}{2} = \frac{L}{R}$

(C) $\sqrt{\frac{3}{2}} = \frac{L}{R}$ (D) $\frac{2}{3} = \frac{L}{R}$



$R = \boxed{\frac{\sqrt{3}}{\sqrt{2}} L}$



$\boxed{\frac{L}{R} = \sqrt{\frac{3}{2}}}$

mass = constt.

ρV = constt.

$\boxed{Vol = constt}$

$\cancel{\pi} R^2 L = \frac{constt}{\pi}$

diff. - R.

$\frac{d(R^2 L)}{dR} = 0$

$2\cancel{R} \cdot L + R^{\cancel{2}} \cdot (dL/dR) = 0$ — ①

$I = M\left[\frac{R^2}{4} + \frac{L^2}{12}\right]$

minimize.

$\frac{dI}{dR} = \frac{\cancel{2}MR}{\cancel{4}_2} + \frac{M}{12}\frac{d(L^2)}{dR} = 0$

① $\frac{dL}{dR} = \frac{-2L}{R}$

$\frac{\cancel{M}R}{2} + \frac{\cancel{M}}{\cancel{12}_6}(\cancel{2}L)\left(\frac{dL}{dR}\right) = 0$

$\frac{R}{\cancel{2}} + \frac{L}{3\cancel{6}}\left(\frac{dL}{dR}\right) = 0$ — ②

$R + \frac{L}{3}\left(\frac{-2L}{R}\right) = 0$

$3R^2 = 2L^2$

JEE 1

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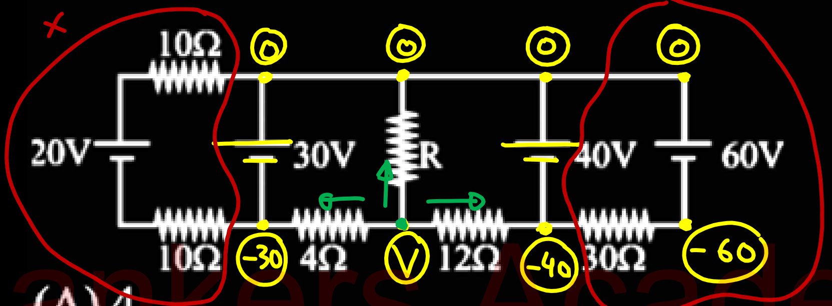
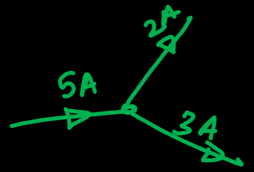
14

In the given circuit, the value of R so that thermal power generated in R will be maximum (in Ω).

$\boxed{P = \frac{V^2}{R}}$

maximize





$-5+2+3=0$

(A) 4

(B) 16

(C) 3

(D) 6

$\sum i_{out} = 0$

$$\frac{V-0}{R} + \frac{V+40}{12} + \frac{V+30}{4} = 0 \quad \text{— } ①$$

$$V \cdot \boxed{\frac{V}{R}} = -\left[\frac{V+40}{12} + \frac{3}{3}\times\frac{V+30}{4}\right] \cdot V = -\left[\frac{4V+130}{12}\right] \cdot V$$

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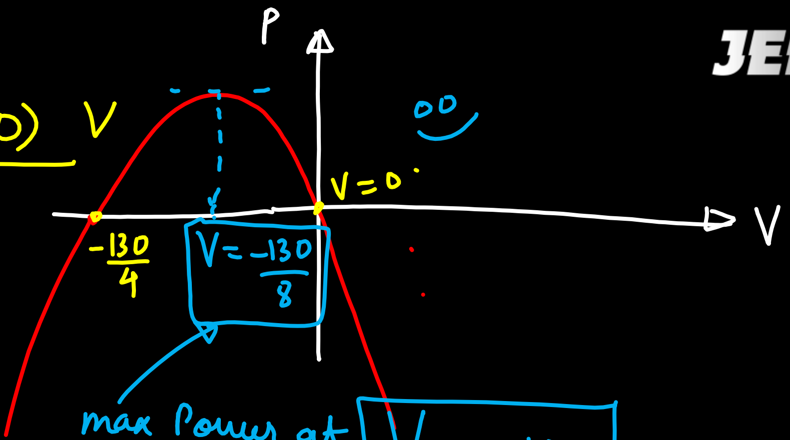
maximize

$$P = \frac{V^2}{R} = -\frac{(4V+130)\,V}{120}$$



max Power at $\boxed{V = -\frac{130}{8}}$

in ①

$$\frac{-\frac{130}{8}}{R} + \frac{-\frac{130}{8}+30}{4} + \frac{-\frac{130}{8}+40}{12} = 0$$

$$\boxed{R=3}$$

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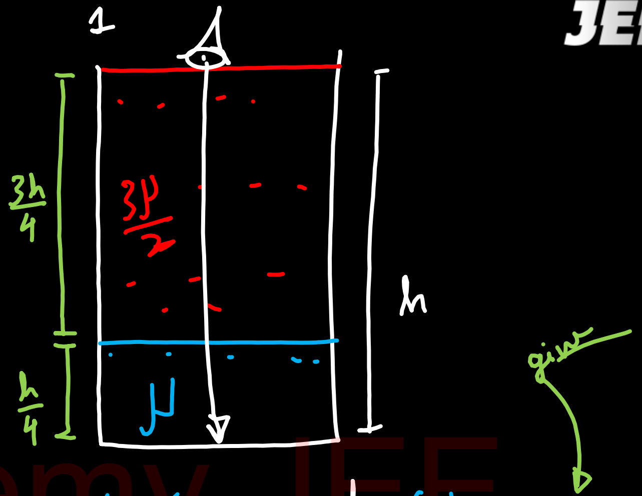
15

A vessel is quarter filled with a liquid of refractive index μ. The remaining parts of the vessel is filled with an immiscible liquid of refractive index 3μ/2. The apparent depth of the vessel is 50% of the actual depth. The value of μ is :

(A) 1 (B) 3/2

(C) 2/3 (D) 4/3



$$h' = \frac{\frac{3h}{4}(1)}{\left(\frac{3\mu}{2}\right)} + \frac{\frac{h}{4}(1)}{(\mu)} = \frac{h}{2}$$

$$\frac{h}{2\mu} + \frac{h}{4\mu} = \frac{h}{2}$$

$$\frac{3}{4\mu} = \frac{1}{2}$$

$$\boxed{\mu = 3/2}$$

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JEE1

16

JEE 1

Two resistors 400Ω and 800Ω are connected in series across a 6 V battery. The potential difference measured by a voltmeter of 10kΩ across 400Ω resistor is close to

~~(A) 2 V~~ ~~(B) 1.8 V~~

(C) 2.05 V (D) 1.95 V

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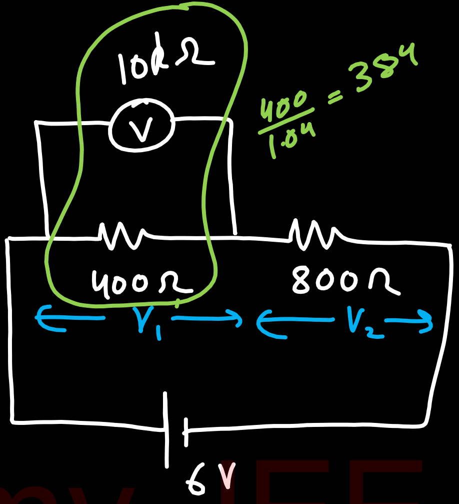

$\frac{400}{1.04} = 384$

originally $\frac{V_1}{V_2} = \frac{400}{800} = \frac{2V}{4V}$

$\boxed{V_1 = 2V}$

After $\frac{V_1'}{V_2'} = \frac{\left(\frac{400 \times 10000}{10400}\right)}{800} = \frac{\frac{400}{1.04}}{800} = \frac{384}{800}$

$V_1' = \frac{V \times 384}{384 + 800} = 6 \times \frac{384}{1184}$

$= 1.95V$

17

Sixty four conducting drops each of radius 0.02 m and each carrying a charge of 5μC are combined to form a bigger drop. The ratio of surface density of bigger drop to the smaller drop will be

(A) 1:4 (B) 4:1

(C) 1:8 (D) 8:1

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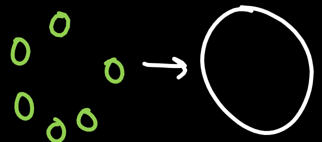

$$64\left(\frac{4}{3}\pi r^3\right) = \frac{4}{3}\pi R^3$$

$$\boxed{4r = R}$$

$$\frac{\sigma_1}{\sigma_2} = \frac{\frac{64q}{4\pi R^2}}{\frac{q}{4\pi r^2}}$$

$$= \frac{64}{\frac{(4r)^2}{r^2}}$$

$$= \frac{64}{4^2} = 4:1$$

18

JEE 1

What is the $\boxed{\text{conductivity}}$ σ of a semiconductor sample having electron concentration of $5 \times 10^{18}\ m^{-3}$, hole concentration of $5 \times 10^{19}\ m^{-3}$, electron mobility of $2.0\ m^2\ V^{-1}\ s^{-1}$ and hole mobility of $0.01\ m^2\ V^{-1}\ s^{-1}$? (Take charge of electron as $1.6 \times 10^{-19} C$)

$n_e =$ $n_h =$ μ_e μ_h

(A) $1.83(\Omega - m)^{-1}$

(B) $1.68(\Omega - m)^{-1}$

(C) $1.20(\Omega - m)^{-1}$

(D) $0.59(\Omega - m)^{-1}$

$\mu = \frac{v_d}{E}$

$\boxed{\sigma = en\mu}$ *

$\sigma = e(n_e\mu_e + n_h\mu_h)$

$= 1.6 \times 10^{-19}(10 \times 10^{18} + 0.05 \times 10^{19})$

$= 1.6(1.05)$

$= 1.68\ \mho\text{-}m^{-1}$

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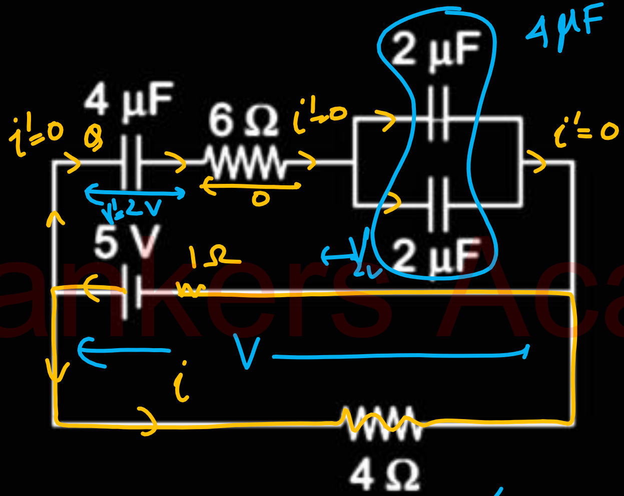
19

Calculate the amount of charge on capacitor of 4μF. The internal resistance of battery is 1Ω.



(A) 4μC (B) 8μC

(C) 16μC (D) zero

$i = \frac{\varepsilon}{R+r} = \frac{5}{4+1} = 1A$

$V = iR = \varepsilon - ir$

$V = 4V$

$V' = 2V$

$Q = CV'$

$= 4\mu F \times 2V$

$= 8\mu C$

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20

JEE 1

Consider the nuclear fission

$Ne^{20} \longrightarrow 2He^4 + C^{12}$

Given that the binding energy/ nucleon of Ne^{20}, He^4 and C^{12} are, respectively, 8.03MeV, 7.07MeV and 7.86MeV, identify the correct statement.

(A) energy of 11.9MeV has to be supplied

(B) energy of 9.72MeV has to be supplied

(C) 8.3MeV energy will be released

(D) energy of 3.6MeV will be released

$\boxed{Q = B.E_P - B.E_R}$

$= 2 \times 4 \times (7.07)$

$+ 12\ (7.86)$

$- 20\ (8.03)$

$= 150.80 - 160.60$

$= -9.72\ MeV$

E needs to be supplied

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21

JEE 1

The stopping potential for photoelectrons emitted from a surface illuminated by light of wavelength 6630Å is 0.42 V. If the threshold frequency is $x \times 10^{13}$/s, where x is ______ (nearest integer).

(Given, speed light $= 3 \times 10^8$ m/s, Planck's constant $= 6.63 \times 10^{-34}$ Js)

$\lambda =$ V_0

$$\boxed{K_{max} = eV_0 = \frac{hc}{\lambda} - \varphi}$$

$$\varphi = \frac{hc}{\lambda} - eV_0$$

$$h\upsilon_0 = \frac{hc}{\lambda} - eV_0$$

$$\upsilon_0 = \frac{c}{\lambda} - \frac{eV_0}{h}$$

$$= \frac{3\times10^8}{6.63\times10^{-7}} - \frac{1.6\times10^{-19}\times0.42}{6.63\times10^{-34}}$$

$$= \frac{10^{15}}{6.63}\left[3 - 1.6\times0.42\right]$$

$$= \frac{2.328}{6.63}\times10^{15}$$

$$= \frac{232.8}{6.63}\times10^{13}$$

$$= 35.11\times10^{13} = 35\times10^{13}\,Hz$$

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22

JEE 1

Suppose that intensity of a laser is $\left(\frac{315}{\pi}\right)$ W/m^2. The magnitude of electric field, in units of V/m associated with this source is close to the nearest integer is ______

E_0

$(\varepsilon_0 = 8.86 \times 10^{-12} C^2 N m^{-2}; c = 3 \times 10^8 m s^{-1})$

$I = \frac{1}{2}\varepsilon_0 E_0^2 c \Rightarrow E_0 = \sqrt{\frac{2I}{\varepsilon_0 c}}$

$\sqrt{\frac{2 \times 315 \times 4}{4\pi\varepsilon_0 c}}$

$= \sqrt{\frac{2 \times 315 \times 4 \times 9 \times 10^9}{3 \times 10^8}}$

$= 6\sqrt{\frac{6300}{3}}$

$= 60\sqrt{21}$

$= 60 \times 4.58$

$= 274.95$

$\simeq 275$ V/m

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23

JEE 1

The width of one of the two slits in a Young's double slit experiment is three times the other slit. If the amplitude of the light coming from a slit is proportional to the slit width, the ratio of minimum to maximum intensity in the interference pattern is $x : 4$ where x is______

$I \propto A^2 \propto w^2$

$\frac{I_1}{I_2} = \left(\frac{3w}{w}\right)^2 = \frac{9}{1}$ — (1)

$\frac{I_{min}}{I_{max}} = \frac{(\sqrt{I_1} - \sqrt{I_2})^2}{(\sqrt{I_1} + \sqrt{I_2})^2}$

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

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

$x = 1$ Ans

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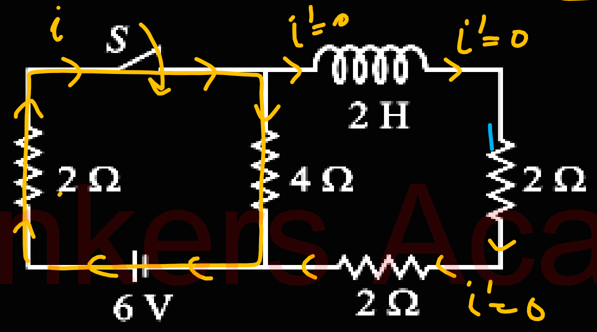
24

JEE 1

For the given circuit the current through battery of 6 V just after closing the switch 'S' will be______ A.



$t = 0$

$L\frac{di}{dt}$ = large

$i' = 0$

'L' is broken circuit.

$i = \frac{\mathcal{E}}{R_{eq}} = \frac{6V}{2+4} = 1A$

Ans

$t \to \infty$

L is a conductor

$i = \frac{\mathcal{E}}{R_{eq}} = \frac{6V}{2+2}$

$= 1.5\ A$

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25

JEE 1

A current of 10 A exists in a wire of cross sectional area of 5 mm^2 with a drift velocity of 2×10^{-3} m s^{-1}. The number of free electrons in each cubic meter of the wire is____ $\times 10^{25}$

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$$i = neAv_d$$

$$n = \frac{i}{eAv_d}$$

$$= \frac{\cancel{10}\,A}{1.6 \times 10^{-19} \times \cancel{5} \times 10^{-6} \times \cancel{2} \times 10^{-3}} = \frac{1}{1.6} \times 10^{28} = \frac{1000}{1.6} \times 10^{25}$$

$$= \boxed{625} \times 10^{25}$$

CHEMISTRY

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1

JEE 1

A Radiations corresponding to the transition $n = 3$ to $n = 1$ in hydrogen atom falls on a certain metal of work function 3eV :

(I) The maximum kinetic energy of the photoelectron will be 9.09eV

(II) Stopping potential will be 9.09 V

(III) The maximum kinetic energy of the photoelectron will be 8.09eV

(IV) Stopping potential will be 8.09 V

Select the correct options

(A) I, IV
(B) I, II
(C) II, III
(D) III, IV

$E(eV) = 13.6\left[\frac{1}{1^2} - \frac{1}{3^2}\right]$

$= 12\, eV$

$E - \phi = KE_{max}$

$12\, eV - 3\, eV = 9\, eV$

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2

Select the correct option :

(A) I,IV (B) I, II

(C) II, III (D) III, IV

JEE 1

The correct set of quantum numbers (n, ℓ, m, s) for the last electron of Rb^+ is –

(A) $4,2,1,\frac{1}{2}$ (B) $5,0,1,\frac{1}{2}$

(C) $4,1,-1,\frac{1}{2}$ (D) $5,0,0,\frac{1}{2}$

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Rb^+ : $[Ar]3d^{10}4s^2\underbrace{4p^6}$

$n = 4$

$\ell = 1$

$m = -1, 0, +1$

$s = +\frac{1}{2}, -\frac{1}{2}$

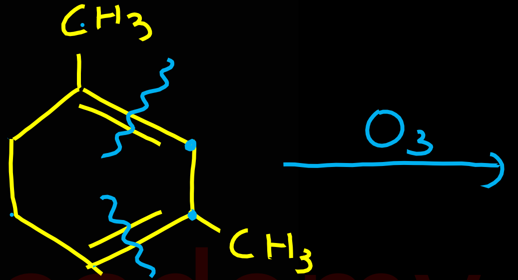
Which of the following products are obtained on ozonolysis reaction of 1,3Dimethylcyclohexa-1,3-diene.

(i) $CH_3-\underset{\underset{O}{\parallel}}{C}-CH=O$

(ii) $CH_3-\underset{\underset{O}{\parallel}}{C}-CH_2-CH_2-CH=O$

(iii) $CH_3-\underset{\underset{O}{\parallel}}{C}-CH_2-CH=O$

(iv) $CH_3-\underset{\underset{O}{\parallel}}{C}-CH_2-\underset{\underset{O}{\parallel}}{C}-CH_3$



$CH_3-\underset{\underset{O}{\parallel}}{C}-CH_2-CH_2-CHO$ +

$CH_3-\underset{\underset{O}{\parallel}}{C}-CHO$

(A) i & ii　　(B) i & iii

(C) i & iv　　(D) ii & iii

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4

For the reaction, $A \rightleftharpoons nB$ the concentration of A decreases from 0.06 to 0.03 mol L^{-1} and that of B rises from 0 to 0.06 molL^{-1} to attain equilibrium. The values of n and the equilibrium constant for the reaction, respectively, are :

(A) 2 and 0.12 (B) 2 and 1.2

(C) 3 and 0.12 (D) 3 and 1.2

JEE 1

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$$A \rightleftharpoons nB$$

	A	nB
$t_{initial}$	0.06	0
t_{eq}	0.03	0.06

$\boxed{n=2}$

$$K = \frac{[B]^2}{[A]} = \frac{0.06 \times 0.06}{0.03} = 0.12$$

The pyrimidine bases present in DNA are

(A) cytosine and guanine

(B) cytosine and thymine

(C) cytosine and uracil

(D) cytosine and adenine

JEE1

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6

Which of the following atoms has the lowest first ionization energy?

(A) Na (B) K

(C) Sc (D) Rb

Na

K

Rb

JEE 1

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7

According to VBT, which of the following possible overlapping results, π-type covalent bond in O_2 molecule formation, when Z-axis is internuclear axis?

(I) $2s - 2s$

(II) $2p_x - 2p_x$

(III) $1s - 1s$

(IV) $2p_y - 2p_y$

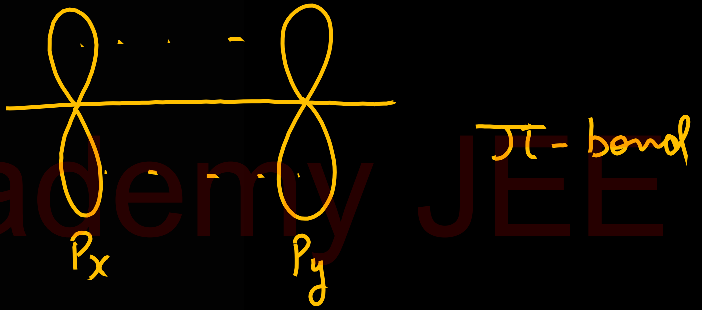
(V) $2p_z - 2p_z$

(A) I, III

(B) II, V

(C) II, IV

(D) IV, V



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8

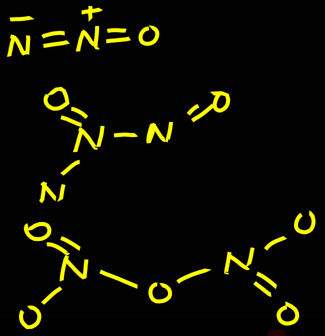
Which of the following molecule does not have $N-N$ bond. (any single or multiple bond)

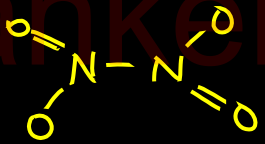
(A) N_2O

(B) N_2O_3

(C) N_2O_5

(D) N_2O_4





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A reaction at 300 K with $\Delta G^\circ = -1743$ J/mol consists of 3 mole of A(g), 6 mole of B(g) and 3 mole of C(g). If A, B and C are in equilbrium in 1 litre container then the reaction may be

$\boxed{[\text{Given} : 2 = e^{0.7}}$, R = 8.3 J/K - mol]

(~~A~~) $A + B \rightleftharpoons C$ $\quad k = \frac{[C]}{[A][B]}$

(B) $A \rightleftharpoons B + 2C$ $\quad k = \frac{C^2 \times B}{A}$

(C) $2A \rightleftharpoons B + C$

(D) $A + B \rightleftharpoons 2C$ $\quad k = \frac{C^2}{A \times B}$

$k = \frac{[B][C]}{[A]^2} = \frac{6 \times \cancel{3}}{3^{\cancel{2}}} = 2$

$2 = e^{0.7}$

$\boxed{\ln 2 = 0.7}$

$\Delta G = -RT \ln k$

$-1743 \text{ J/mol} = -8.3 \times 300 \times \ln k$

$\ln k = 0.7$

$k = 2$

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JEE 1

10

JEE 1

S_1 : On adding acid to aqueous solution of K_2CrO_4 , its colour changes from yellow to orange.

S_2 : CrO_4^{2-} and $Cr_2O_7^{2-}$ exist in equilibrium over wide range of pH from 2 to 6.

$$CrO_4^{2-} \underset{}{\overset{H^+}{\rightleftharpoons}} Cr_2O_7^{2-}$$

(A) Statement-1 is correct statement-2 is not a correct explanation of statement-1

(B) Statement-1 is correct statement-2 is also a correct explanation of statement-1

(C) Statement-1 is correct statement-2 is not correct.

(D) Statement-1 is not correct and statement2 is correct.

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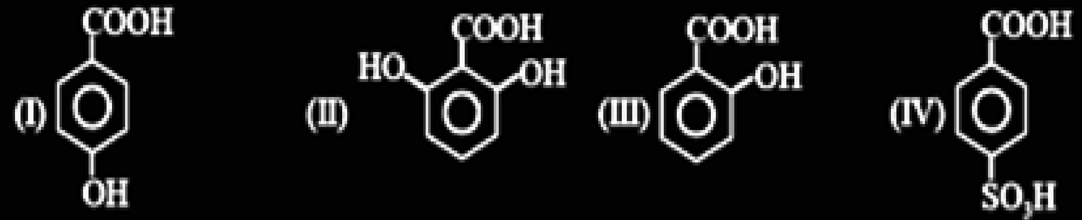
11

Correct order of acidic strength of given compound is :



(A) II > III > IV > I (B) IV > III > I > II

(C) IV > II > III > I (D) II > I > III > IV

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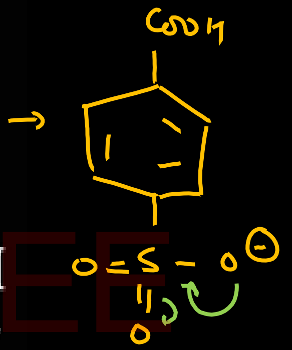
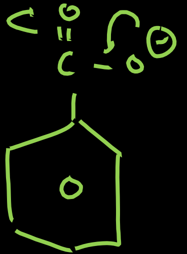
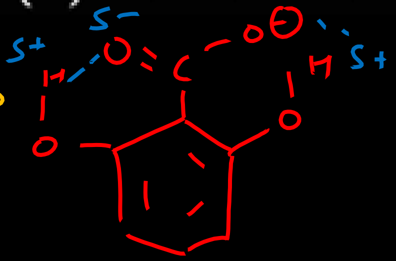




Acidity ∝ stability of C.B

∝ EWG



H-bonding

12

JEE 1

Match the column I with column II and mark the appropriate choice.

Column I (Complex)		Column II (Magnetic moment of central atom)
(a) $[Fe(CN)_6]^{3-}$		(i) 0
(b) $[CoF_6]^{3-}$		(ii) 5.92 B.M.
(c) $[Fe(H_2O)_6]^{3+}$	$n=5$	(iii) 4.89 B.M.
(d) $[Co(NH_3)_6]^{3+}$		(iv) 1.732 B.M.

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(A) (a) (ii), (B) (iii), (C) (iv), (D) (i)

(B) (a) (iii), (B) (ii), (C) (i), (D) (iv)

(C) (a) (i), (B) (iii), (C) (iv), (D) (ii)

✓(D) (a) (iv), (B) (iii), (C) (ii), (D) (i)

(a) $Fe^{+3}: 3d^5$

$\boxed{1L \mid 1L \mid 1 \mid \ \mid \ }$ $n=1$

$\mu = \sqrt{n(n+2)} = \sqrt{3} = 1.73$

(b) $Co^{+3}: 3d^6$

$\boxed{1L \mid 1 \mid 1 \mid 1 \mid 1}$ $n=4$

$\mu = \sqrt{24}$

13

Which of the following acids is monobasic?

(A) Hypophosphorous acid (H_3PO_2)

(B) Orthophosphoric acid (H_3PO_4)

(C) Pyrophosphoric acid ($H_4P_2O_7$)

(D) Hypophosphoric acid ($H_4P_2O_6$)

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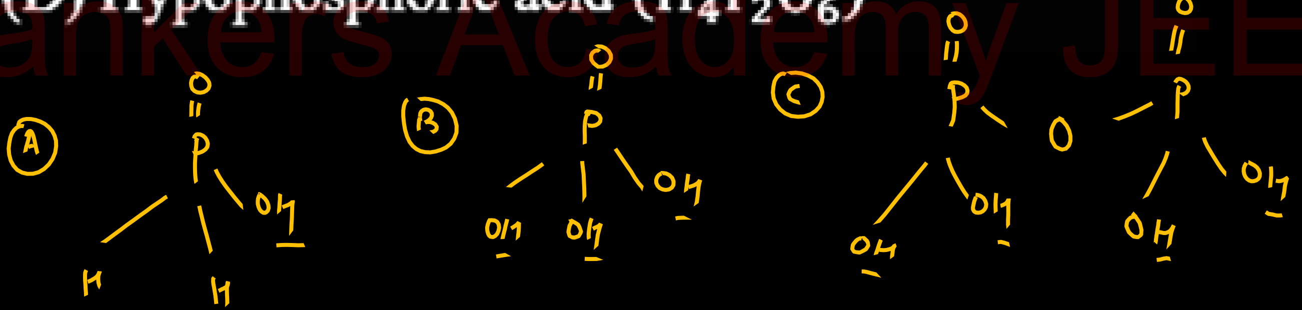

14

On heating ammonium dichromate, the gas evolved is :

(A) oxygen

(B) ammonia

(C) nitrous oxide

(D) nitrogen

JEE 1

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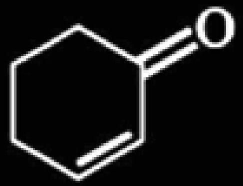
$$(NH_4)_2Cr_2O_7 \xrightarrow{\Delta} N_2\uparrow + Cr_2O_3 + H_2O$$

JEE 1

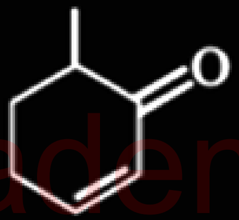
15

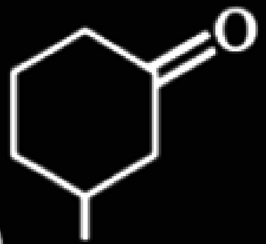


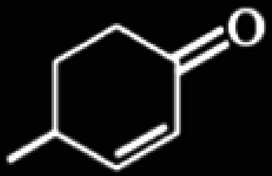
$\xrightarrow[\text{(ii)}H_2O]{\text{(i)}CH_3MgI/CuI}$ J (Major)

J is

(A) 

(B) 

(C) 

(D) 

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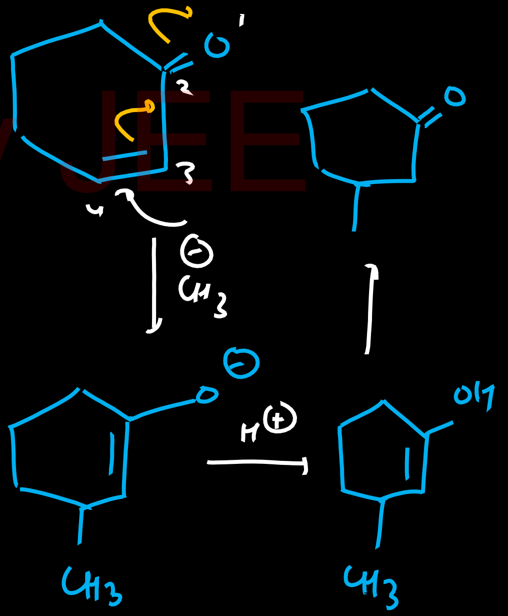

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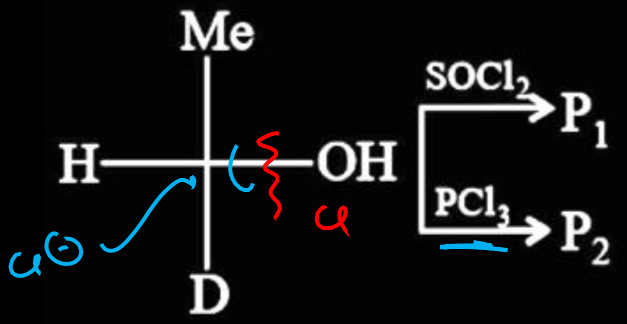
16

Select the correct product from the following

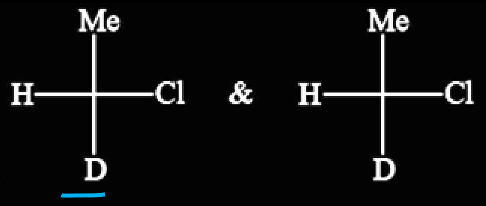


retention.

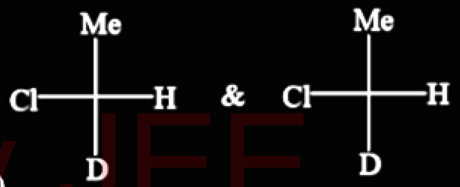
Inversion.

P_1 & P_2 are respectively.

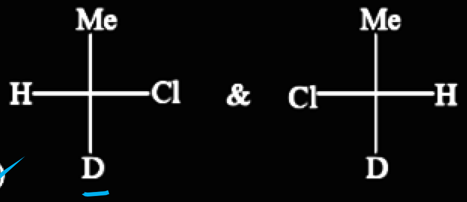
(A)



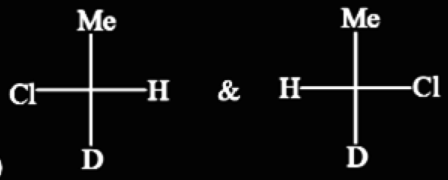
(B)



(C)



(D)



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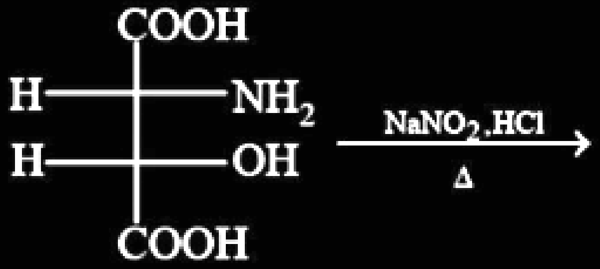
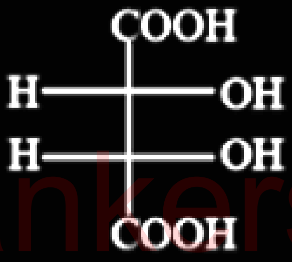
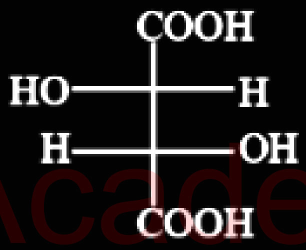
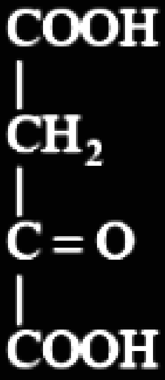
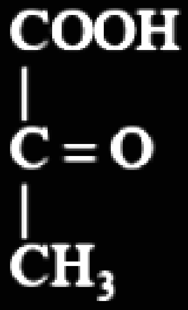
17

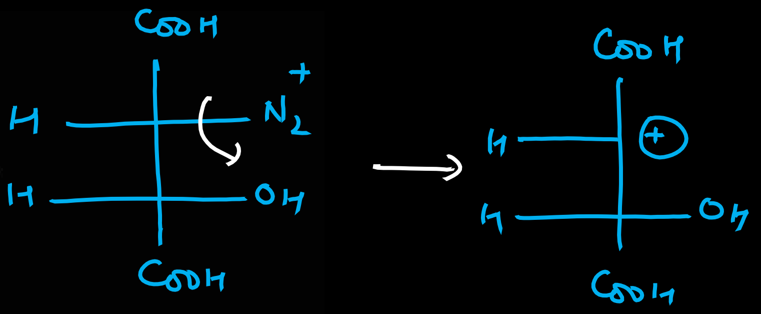


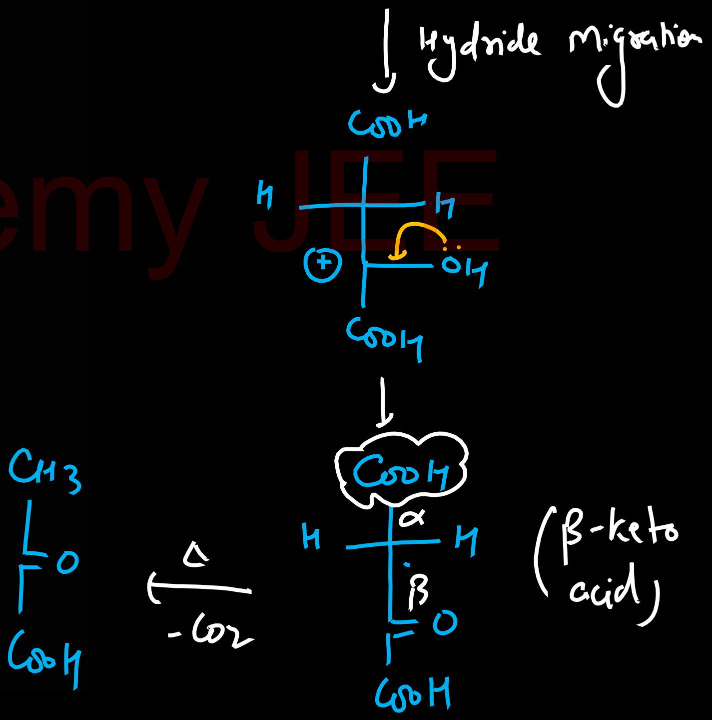
(A)


(B)


(C)


(D)






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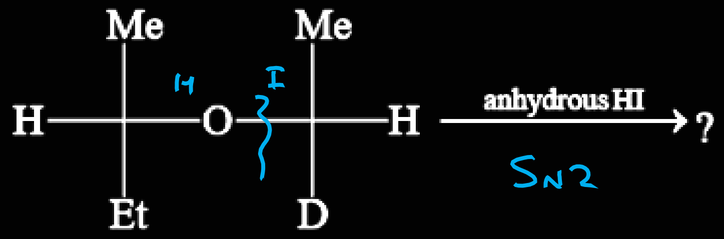
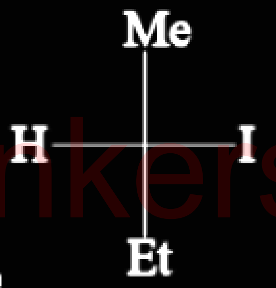
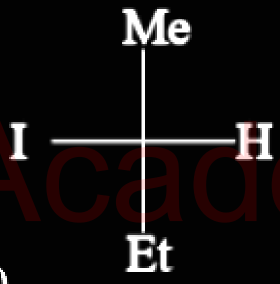
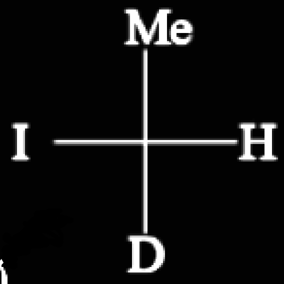
18

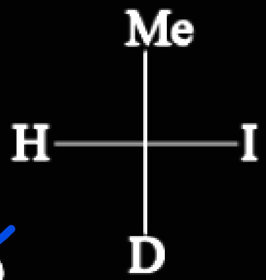


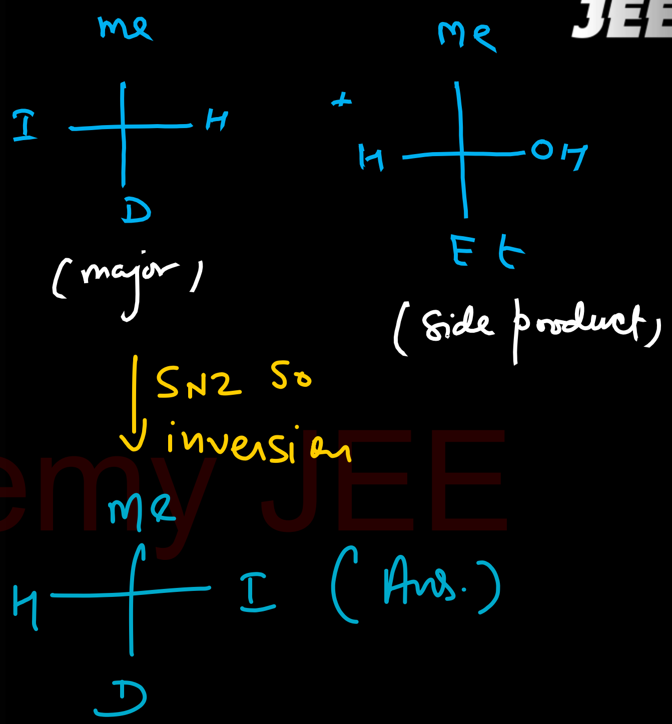
Major product is

(A)


(B)


(C)


(D)




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19

JEE 1

Unlike $PbCl_4$, PbI_4 and $PbBr_4$ are not found because :

(A) bromine and iodine are more electronegative than chlorine.

(B) iodine and bromine are smaller in size.

(C) larger iodine and bromine are able to reduce Pb^{4+} to Pb^{2+} or Pb.

(D) the statement is incorrect.

Pb^{+4}

Polarisation $\propto \frac{1}{\text{Size of Cation}} \propto$ Size of anion

$I^{\ominus} \longrightarrow I_2$

$Br^{-} \longrightarrow Br_2$

Rankers Academy JEE

20

In the reaction sequence

$$A \xrightarrow{SnCl_2/HCl} B \xrightarrow[0^\circ]{NaNO_2/HCl} C \xrightarrow{H_2O/\Delta} C_6H_5OH,$$

A, B and C are :-

(A) Benzene, nitrobenzene, aniline

(B) Nitrobenzene, aniline and azo-compound

(C) Nitrobenzene, benzene, aniline

(D) Benzene, amino compound, aniline

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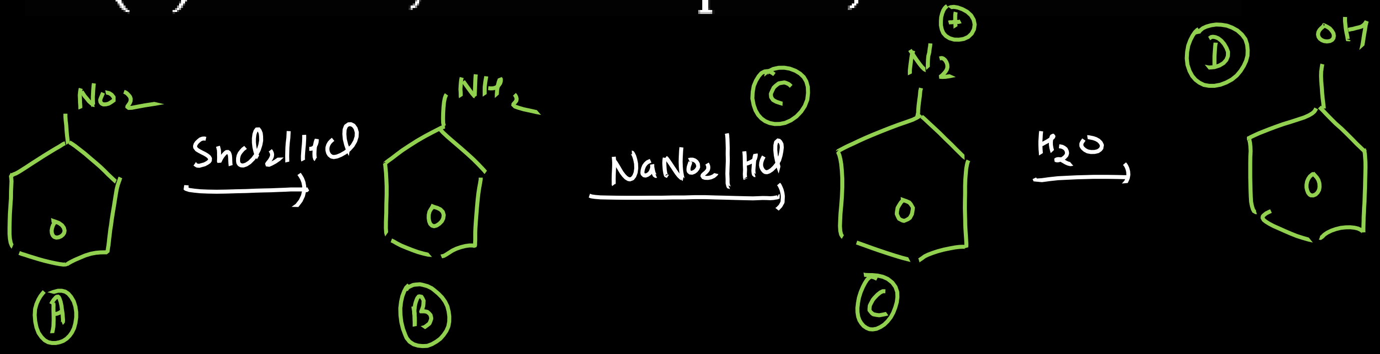

21

JEE 1

In a saturated solution of the sparingly soluble strong electrolyte $AgIO_3$ (Molecular mass = 283) the equilibrium which sets in is

$AgIO_3(s) \rightleftharpoons Ag^+(aq) + IO_3^-(aq)$

If the solubility product constant K_{sp} of $AgIO_3$ at a given temperature is 1.0×10^{-8}. If the mass of $AgIO_3$ contained in 100ml of its saturated solution is X micrograms. Find X

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$AgIO_3 \rightleftharpoons Ag^+ + IO_3^-$

$K_{sp} = S^2$

$S = \sqrt{K_{sp}} = \sqrt{1.0 \times 10^{-8}}$

$S\,(mol/L) = 10^{-4}$

$S\,(g/L) = 10^{-4} \times 283$

$\mu g/L = 10^{-4} \times 283 \times 10^{6} = 28300\ \mu g/L$

in 100 ml $\Rightarrow \boxed{2830}$

22

JEE 1

Ratio of $\Delta T_b/K_b$ for 6%(W/V)AB_2 is 1 mol/kg and also for 9%(W/V)A_2B it is 1 mol/kg (AB_2 and A_2B both are non-electrolytes). Hence, atomic masses of A and B are respectively: (assume molality = molarity) Fill A - B.

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$\Delta T_b = m K_b$

$\frac{\Delta T_b}{K_b} = m = 1\ mol/kg$

For AB_2,

$m = 1\ mol/kg = \frac{6 \times 10\cancel{00}}{M \times 1\cancel{00}}$

For A_2B

$m = 1 = \frac{9 \times 10\cancel{00}}{M \times 1\cancel{00}}$

Molar mass of $AB_2 = 60$

" " " $A_2B = 90$

$A + 2B = 60$

$2A + B = 90$

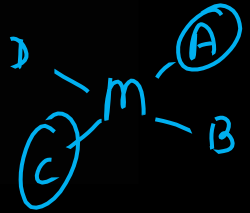
$A = 40$

$B = 10$

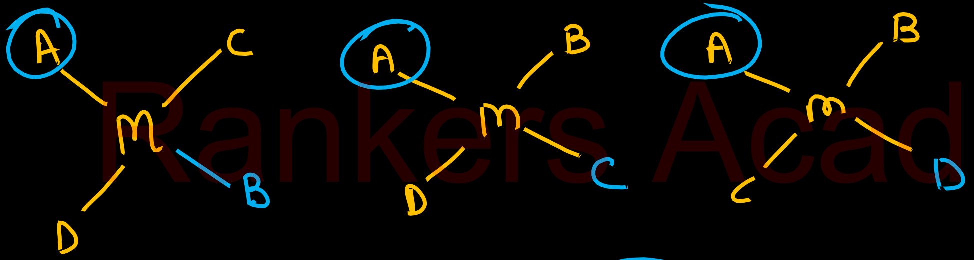
$A - B = 40 - 10 = 30$

23

The total number of possible isomers for square-planar complex $[PtCl(NO_2)(NO_3)(SCN)]^{-2}$ is :



$[M\,ABCD]^{2-}$



Ans 12

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24

JEE1

A fully charged lead-storage battery contains 1.5 L of $5M H_2SO_4$. During discharging of lead-storage acid battery, following reaction takes place.

$$\overset{0}{Pb}(s) + \overset{+4}{Pb}O_2(s) + 2H_2SO_4 \longrightarrow 2\overset{+2}{Pb}SO_4(s) + 2H_2O$$

If 2.5 A of current is drawn for 965 min, H_2SO_4 consumed (in moles) is N moles Fill 10 N

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$$\text{moles of } e^- = \frac{\text{Total charge}}{96500} = \frac{2.5 \times 965 \times 60}{96500}$$

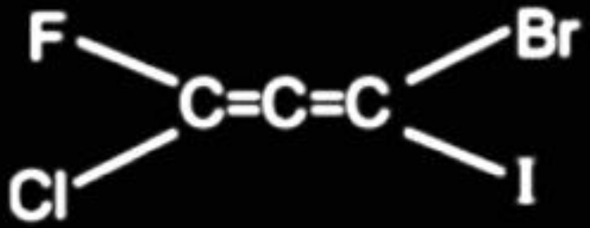
$= 1.5$ moles

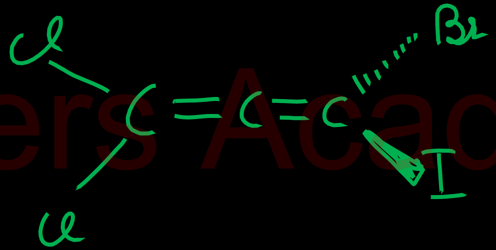
N of H_2SO_4 consumed $= 1.5$

$\boxed{10N = 15}$

25

What is the maximum number of atoms in a one plane in the following compound?





$\boxed{\text{Ans } 5}$

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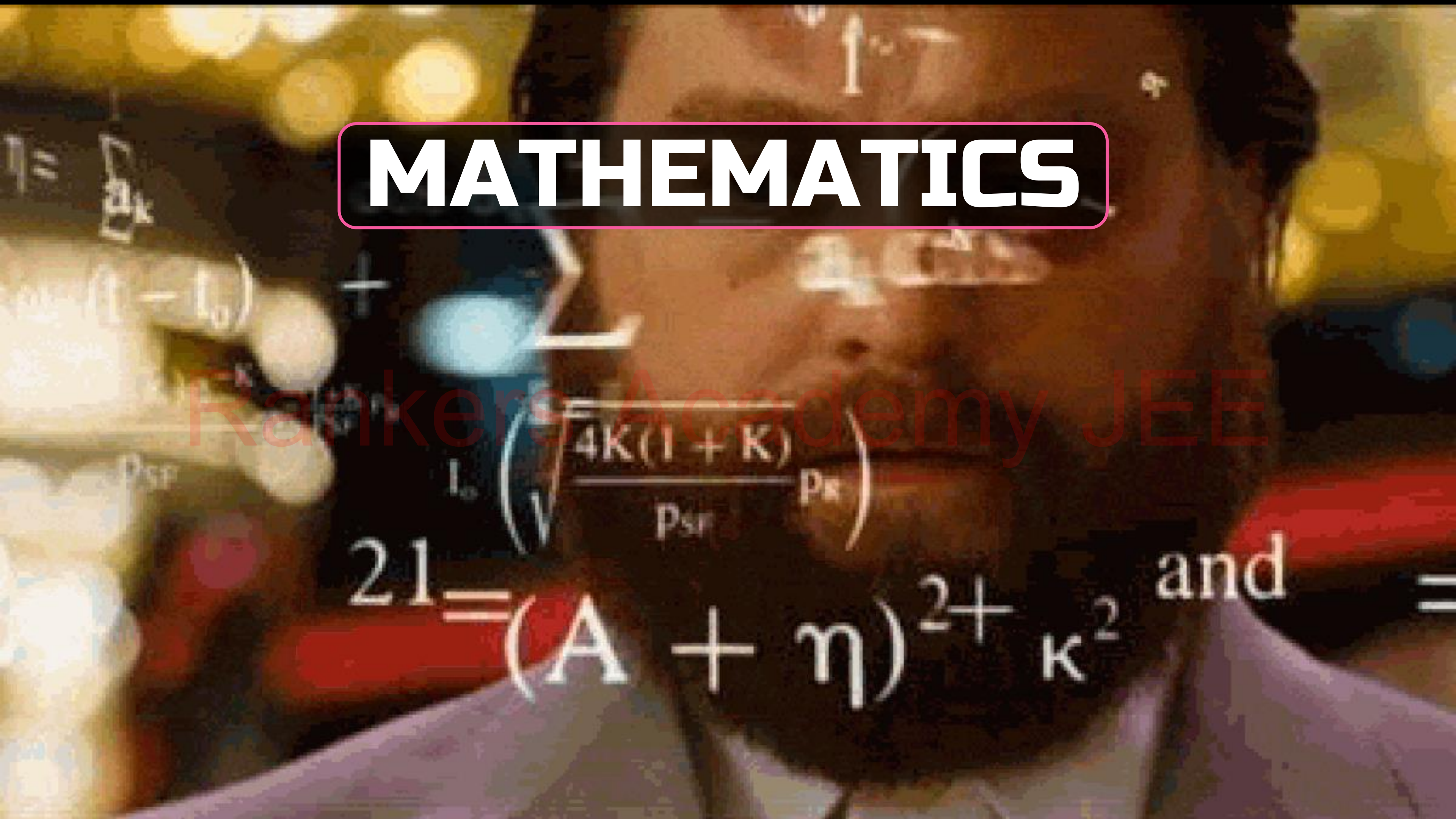
MATHEMATICS



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JEE 1

In the quadratic equation $A(\sqrt{3}-\sqrt{2})x^2 + \frac{B}{(\sqrt{3}+\sqrt{2})}x + C = 0$ with α, β as its roots, if $A = (49+20\sqrt{6})^{1/4}$, B = sum of the infinite G.P as $8\sqrt{3} + \frac{8\sqrt{6}}{\sqrt{3}} + \frac{16}{\sqrt{3}} + \cdots \ldots \infty$ and $|\alpha-\beta| = (6\sqrt{6})^k$, where $k = \log_6 10 - 2\log_6 \sqrt{5} + \log_6 \sqrt{(\log_6 18 + \log_6 72)}$, then find the value of C.

(A) 136 (B) 164

(C) 128 (D) 64

$A = (49+20\sqrt{6})^{1/4}$

$= ((5+2\sqrt{6})^2)^{1/4}$

$= (5+2\sqrt{6})^{1/2}$

$= \sqrt{3}+\sqrt{2}$

$A(\sqrt{3}-\sqrt{2}) = (\sqrt{3}+\sqrt{2})(\sqrt{3}-\sqrt{2}) = 1$

$B = \frac{8\sqrt{3}}{1-\left(\frac{\sqrt{6}/\sqrt{3}}{\sqrt{3}}\right)} = \frac{8\sqrt{3}}{1-\sqrt{\frac{2}{3}}}$

$= \frac{8\sqrt{3}\cdot\sqrt{3}}{\sqrt{3}-\sqrt{2}} = \frac{24}{\sqrt{3}-\sqrt{2}}$

$\frac{B}{\sqrt{3}+\sqrt{2}} = \frac{24}{(\sqrt{3}-\sqrt{2})(\sqrt{3}+\sqrt{2})} = 24$

$\therefore x^2+24x+c=0 < {\alpha \atop \beta}$

$|\alpha-\beta| = \frac{\sqrt{D}}{|a|} = \sqrt{576-4c} = (6^{3/2})^k = 8$

Rankers Academy JEE

$$K = \log_6 10 - \log_6 (\sqrt{5})^2 + \log_6 \sqrt{\log_6 (18 \cdot 72)}$$

$$= \log_6 10 - \log_6 5 + \log_6 \sqrt{\log_6 (18 \times 18 \times 4)}$$

$$= \log_6 2 + \log_6 \sqrt{\log_6 (18 \cdot 2)^2}$$

$$+ \log_6 \sqrt{\log_6 6^4}$$

$$+ \log_6 \sqrt{4 \cdot 1}$$

$$= \log_6 2 + \log_6 2$$

$$= \log_6 4$$

$$\left(6^{3/2}\right)^K = 6^{\frac{3}{2} \log_6 4}$$

$$= 6^{\log_6 (4^{3/2})}$$

$$= 4^{3/2} = 2^3 = 8$$

$$\sqrt{576 - 4c} = 8$$

$$576 - 4c = 64$$

$$4c = 576 - 64$$

$$4c = 512$$

$$c = 128$$

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2

JEE 1

Let $S_n = \frac{3}{4} + \frac{5}{36} + \frac{7}{144} + \frac{9}{400} + \cdots \ldots \ldots$ to ' n ' terms. Then the digit in the 10 ' s place of $\frac{1}{1-S_{40}}$ is____

$2^2 \quad 6^2 \quad 12^2 \quad 20^2$

$1\times2 \quad 2\times3 \quad 3\times4 \quad 4\times5$

(A) 8 (B) 1

(C) 4 (D) 6

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$$T_n = \frac{2n+1}{(n(n+1))^2} = \frac{(n+1)^2 - n^2}{n^2(n+1)^2} = \frac{1}{n^2} - \frac{1}{(n+1)^2}$$

$$S_n = \sum_{n=1}^{n} T_n = \cancel{\frac{1}{1^2}} - \cancel{\frac{1}{2^2}}$$

$$+ \cancel{\frac{1}{2^2}} - \cancel{\frac{1}{3^2}}$$

$$\vdots$$

$$\cancel{\frac{1}{n^2}} - \frac{1}{(n+1)^2}$$

$$S_n = 1 - \frac{1}{(n+1)^2}$$

$$S_{40} = 1 - \frac{1}{41^2}$$

$$\Rightarrow 1 - S_{40} = \frac{1}{41^2}$$

$$\Rightarrow \frac{1}{1-S_{40}} = 41^2 = 1681$$

$$\begin{array}{r} 41 \\ \times 41 \\ \hline 41 \\ 164\times \end{array}$$

The value of θ where

$$\theta = \sin^{-1}\sqrt{\frac{2-\sqrt{3}}{4}} + \cos^{-1}\frac{\sqrt{12}}{4} + \underbrace{\sec^{-1}(\sqrt{2})}_{\frac{\pi}{4}} \text{ is}$$

equal to $\sin^{-1}\sqrt{\frac{4-2\sqrt{3}}{8}}$ $\frac{\pi}{6}$ $\frac{2\sqrt{3}}{4} = \frac{\sqrt{3}}{2}$

$\sin^{-1}\frac{\sqrt{3}-1}{2\sqrt{2}}$

$\frac{\pi}{12}$

(A) 0

(B) $\frac{\pi}{4}$

(C) $\frac{\pi}{6}$

(D) $\frac{\pi}{2}$ ✓

Rankers Academy JEE

Ans: $15^\circ + 30^\circ + 45^\circ$

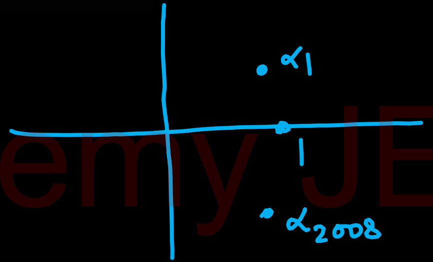
$= 90^\circ$

If $1, \alpha_1, \alpha_2, \alpha_3, \ldots . \alpha_{2008}$ are $(2009)^{th}$ roots of unity, then the value of $\sum_{r=1}^{2008} r(\alpha_r + \alpha_{2009-r})$ is equal to

(A) 2009 (B) 2008

(C) 0 (D) -2009

$$\Rightarrow \sum_{r=1}^{2008} r(\alpha_r + \alpha_{2009-r})$$



$$\Rightarrow 1(\alpha_1 + \alpha_{2008}) + 2(\alpha_2 + \alpha_{2007}) + \ldots + 2007(\alpha_{2007} + \alpha_2) + 2008(\alpha_{2008} + \alpha_1)$$

$$\Rightarrow 2009\left[(\alpha_1 + \alpha_{2008}) + (\alpha_2 + \alpha_{2007}) + (\alpha_3 + \alpha_{2006}) + - - -\right]$$

$$\Rightarrow 2009\left[\alpha_1 + \alpha_2 + \ldots + \alpha_{2008}\right] = 2009(-1)$$

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A letter is known to have come from CHENNAI, MUMBAI, JAIPUR, AIZWAL OR RAIPUR. On the post mark only two consecutive letters AI are legible. The probability that it came from JAIPUR is

(A) $\frac{11}{29}$ (B) $\frac{5}{33}$

(C) $\frac{13}{33}$ (D) $\frac{6}{29}$

Rankers Academy JEE

JEE 1

$$P(\text{Jaipur}/AI) = \frac{\cancel{\frac{1}{5}}\cdot\frac{1}{5}}{\cancel{\frac{1}{5}}\cdot\frac{1}{6} + \cancel{\frac{1}{5}}\cdot\frac{1}{5} + \cancel{\frac{1}{5}}\cdot\frac{1}{5} + \cancel{\frac{1}{5}}\cdot\frac{1}{5} + \cancel{\frac{1}{5}}\cdot\frac{1}{5}}$$

CHENNAI

$$= \frac{\frac{1}{5}}{\frac{1}{6}+\frac{4}{5}} = \frac{6}{29}$$

6

Let A is 3×3 matrix such that $|A| = 2$, then $\operatorname{adj}(\operatorname{adj}(|A|A^2))$ is

(A) $16\,A^2$ (B) $4\,A$

(C) $16\,A$ (D) $64\,A^2$

JEE 1

$\operatorname{adj}(\operatorname{adj}A) = |A|^{n-2}A$

$|\operatorname{adj}(\operatorname{adj}A)| = |A|^{(n-1)^2}$

$\operatorname{adj}(kA) = k^{n-1}\cdot(\operatorname{adj}A)$

$\operatorname{adj}(\operatorname{adj}(2A^2))$

$|2A^2|^1 \quad (2A^2)$

$2^3|A^2| \quad (2A^2)$

$16\cdot4\cdot \quad A^2$

M2

$\operatorname{adj}(2^2\operatorname{adj}(A^2))$

$\operatorname{adj}(4\operatorname{adj}(A^2))$

$4^2\operatorname{adj}(\operatorname{adj}(A^2))$

$16\operatorname{adj}(\operatorname{adj}(A^2))$

$16\,|A^2|^1\,(A^2)$

$16\times4\;A^2$

$64\;A^2$

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7

JEE 1

The number of integral terms in $(\sqrt{5}+\sqrt[8]{7})^{1024}$ is-

(A) 120 (B) 131

(C) 129 (D) 128

$LCM(2,8) = 8$

Rankers Academy JEE

ans : $\left[\frac{1024}{8}\right] + 1$

$128 + 1$

129

8

JEE 1

If R is a relation on the set of natural number such that aRb $\Leftrightarrow$ $a = 3^k . b$ for some integer k, then R is :-

~~(A)~~ Symmetric, transitive but not reflexive

(B) Reflexive, symmetric but not transitive

~~(C)~~ Reflexive, transitive but not symmetric

(D) An equivalence relation

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Ref $a = 3^{k} a$

$k = 0$

Sym $a = 3^k b$

$b = 3^{-k} a$

Trans: $a = 3^{k_1} b$

$b = 3^{k_2} c$

$a = 3^{k_1} . 3^{k_2} . c$

$a = 3^{k_1 + k_2} . c$

JEE 1

The domain of the function

$f(x) = \sin^{-1}\left(\log_2\left(\frac{1}{2}x^2\right)\right)$ is :

(A) $[-2,-1) \cup (1,2]$

(B) $(-2,-1] \cup [1,2]$

(C) $[-2,-1] \cup [1,2]$

(D) $(-2,-1), \cup (1,2)$

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$$-1 \leq \log_2\left(\frac{x^2}{2}\right) \leq 1$$

$$\frac{1}{2} \leq \frac{x^2}{2} \leq 2$$

$$1 \leq x^2 \leq 4$$

$$x \in [-2,-1] \cup [1,2]$$

10

The number of integral values of ' a ' for which the system of linear equations

$x \sin\theta - 2y\cos\theta - az = 0,$

$x + 2y + z = 0, -x + y + z = 0$ may have nontrivial solutions, then which of the following is incorrect :

$\Delta = 0$

(A) at $a = 2$ the given system will have finite solutions for $\theta \in R$

correct (B) number of possible integral values of a is 3

correct (C) for $a = 1$ the system can have infinite solutions

correct (D) for $a = 3$ the system will have unique solution

$$\Delta = \begin{vmatrix} \sin\theta & -2\cos\theta & -a \\ 1 & 2 & 1 \\ -1 & 1 & 1 \end{vmatrix} = 0$$

$\Rightarrow \sin\theta + 4\cos\theta - 3a = 0$

$\Rightarrow a = \frac{1}{3}(\sin\theta + 4\cos\theta)$

$$\frac{-\sqrt{1^2+4^2}}{3} \le a \le \frac{\sqrt{1^2+4^2}}{3}$$

$-1.$ $\quad -\frac{\sqrt{17}}{3} \le a \le \frac{\sqrt{17}}{3}$ $1.$

Rough $-1.1 \le a \le 1.1$

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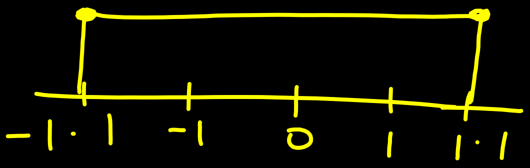
JEE 1



3 int

$-1, 0, 1$

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Homo eq

$\Delta \neq 0$

Trivial sol.

· Unique sol.

$x = y = z = 0$

$a < -1.1$ or $a > 1.1$

· $a = 3$

$a = 2$

$\Delta = 0$

Non-trivial sol

∞ sol.

$-1.1 \leq a \leq 1.1$

11

JEE 1

If a and b are chosen randomly from the set consisting of numbers 1,2,3,4,5 and 6 with replacement. Then the probability that

$$\lim_{x\to 0}\left(\frac{a^x+b^x}{2}\right)^{2/x}=6$$

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

(B) $\frac{1}{9}$

(C) $\frac{2}{9}$

(D) $\frac{4}{9}$

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$$e^{\lim_{x\to 0}\left(\frac{2}{x}\right)\left(\frac{a^x+b^x}{2}-1\right)}$$

$$\Rightarrow e^{\lim_{x\to 0}\frac{\cancel{2}}{x}\frac{a^x-1+b^x-1}{\cancel{2}}}$$

$$\Rightarrow e^{\lim_{x\to 0}\frac{a^x-1}{x}+\frac{b^x-1}{x}}$$

$$\Rightarrow e^{\ln a+\ln b}$$

$$\Rightarrow e^{\ln(ab)}=ab$$

$$\boxed{ab=6}$$

$a,b\in\{1,2,3,4,5,6\}$

a	b
1	6
6	1
2	3
3	2

$$\frac{4}{6\times 6}$$

12

If R and Q are two events such that $P(Q) = \frac{1}{2}$ and $P(R) = \frac{2}{3}$, then which of the following is incorrect

(A) $P(R' \cap Q) \geq \frac{1}{3}$ (B) $P(Q \cup R) \geq \frac{2}{3}$ c

(C) $\frac{1}{6} \leq P(Q \cap R) \leq \frac{1}{2}$ (D) $\frac{1}{6} \leq P(Q' \cap R) \leq \frac{1}{2}$

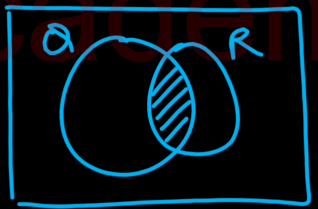
$0 \leq P(Q) \leq 1 \longrightarrow P(Q) = 1/2$

$0 \leq P(R) \leq 1 \longrightarrow P(R) = 2/3$

$\therefore P(Q \cap R) \leq \frac{1}{2}, \frac{2}{3}$

common

$0 \leq \boxed{P(Q \cap R) \leq \frac{1}{2}}$



$P(Q \cup R) = P(Q) + P(R) - P(Q \cap R)$

$= \frac{1}{2} + \frac{2}{3} - P(Q \cap R)$

$P(Q \cup R) = \frac{7}{6} - P(Q \cap R) \leq 1$

$\boxed{\frac{1}{6} \leq P(Q \cap R)}$

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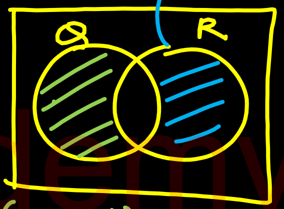
$P(Q\cup R) = \frac{7}{6} - P(Q\cap R)$

$P(Q\cap R) = \frac{7}{6} - P(Q\cup R) \leq \frac{1}{2}$

$\frac{7}{6} - \frac{1}{2} \leq P(Q\cup R)$

$= \frac{2}{3}$



$Q'\cap R \leq P(R)$

$\leq \frac{2}{3}$

$P(Q'\cap R) = \frac{2}{3} - P(Q\cap R)$

$\frac{2}{3} - \frac{1}{6}$ $\quad$ $\frac{2}{3} - \frac{1}{2}$

$\frac{3}{6} = \frac{1}{2}$ $\quad$ $\frac{1}{6}$

$P(Q\cap R') \leq P(Q)$

$\leq \frac{1}{2}$

$P(Q\cap R') = P(Q) - P(Q\cap R)$

$= \frac{1}{2} - P(Q\cap R)$

$\frac{1}{2} - \frac{1}{2} = 0$ $\quad$ $\frac{1}{2} - \frac{1}{6} = \frac{1}{3}$.

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13

JEE 1

Let $a_1, a_2, a_3, \dots a_{201}$ are in G.P. with $a_{101} = 25$ and $\sum_{i=1}^{201} a_i = 625$. Then the value of $\sum_{i=1}^{201} \frac{1}{a_i}$ equals

(A) 1 (B) 5

(C) 625 (D) 1/625

GP $a_1, a_2, \dots a_{201}$

$a, ar, \dots ar^{200}$

$a_{101} = \boxed{ar^{100} = 25}$ — (1)

$625 = a\left(\frac{r^{201}-1}{r-1}\right)$ — (2)

$\frac{1}{a} \quad \frac{1}{ar} \quad \frac{1}{ar^2} \dots \frac{1}{ar^{200}}$

GP : first term : $1/a$

c.r. : $1/r$

$\frac{1}{a}\left(\frac{\frac{1}{r^{201}}-1}{\frac{1}{r}-1}\right) = \frac{1}{a}\frac{(1-r^{201})}{(1-r)r^{200}}$

$= \frac{1}{a\, r^{200}} \cdot \frac{625}{a}$

$1 = \frac{625}{25^2} = \frac{625}{(ar^{100})^2}$

Rankers Academy JEE

14

JEE 1

Consider two curves $C_1 : y^2 = 4[\sqrt{y}]x$ and $C_2 : x^2 = 4[\sqrt{x}]y$ where [.] denotes the greatest integer function, then the area of region enclosed by these enclosed by these two curves within the square formed by the lines $x = 1, y = 1, x = 4, y = 4$

(A) $\frac{11}{9}$ (B) $\frac{11}{7}$

(C) $\frac{11}{5}$ (D) $\frac{11}{3}$

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$x : 1 \longrightarrow 4$

$\sqrt{x} : 1 \longrightarrow 2$

$[\sqrt{x}] = 1$

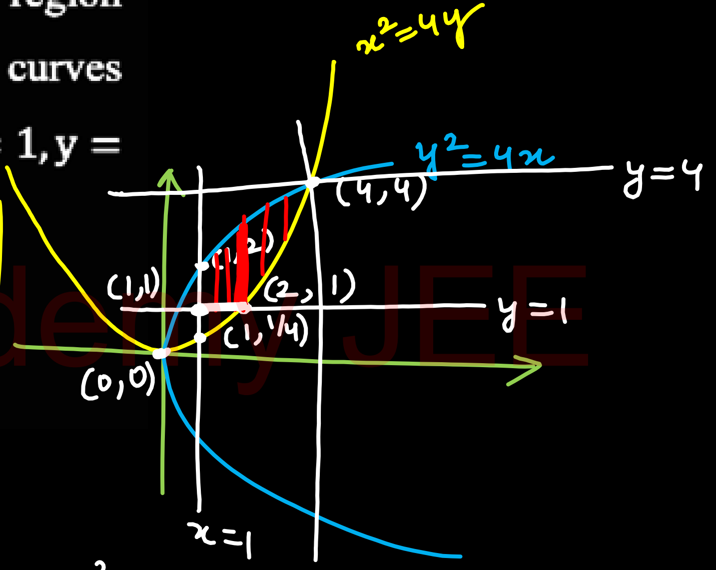
$C_2 : x^2 = 4y$

$y \rightarrow 1 \rightarrow 4$

$\sqrt{y} \quad 1 \rightarrow 2$

$[\sqrt{y}] = 1$

$C_1 : y^2 = 4x$



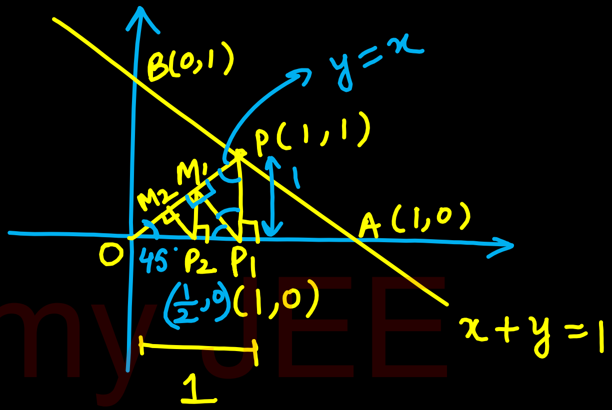
$$\int_1^2 \sqrt{4x} - 1 \, dx + \int_2^4 \sqrt{4x} - \frac{x^2}{4} dx$$

The line $x + y = 1$ meets x-axis at A and y-axis at B, P is the mid point of AB, P_1 is the foot of the perpendicular from P to OA; M_1 is that of P_1 to OP, P_2 is that of M_1 to OA; M_2 is that of P_2 to OP, P_3 is that of M_2 to OA; and so on. If P_n denotes the n^{th} foot of the perpendicular on OA; then OP_n is

(A) $\left(\frac{1}{2}\right)^{n-1} \rightarrow 1$ (B) $\left(\frac{1}{2}\right)^{n} \rightarrow \frac{1}{2}$

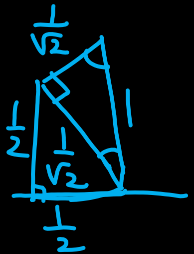
(C) $\left(\frac{1}{2}\right)^{n+1} \rightarrow \frac{1}{4}$ (D) $(0.5)^{2n-1} \rightarrow \frac{1}{2}$

$n=1$



$P_1 \equiv (1,0)$

$\frac{x-1}{-1} = \frac{y-0}{1} = \frac{-(0-1)}{2}$



M_1 $x = 1/2$, $y = 1/2$

$P_1\left(\frac{1}{2}, 0\right)$

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16

Which of the following option(s) is not correct?

(A) $\frac{x^2}{\sec^2\theta}+\frac{y^2}{\tan^2\theta}=1$ and $\frac{x^2}{\cos^2\theta}-\frac{y^2}{\sin^2\theta}=1$ intersects each other orthogonally for all $\theta \in \left(0,\frac{\pi}{2}\right)$ → T

(B) $\frac{x^2}{2\sec^2\theta}+\frac{y^2}{2\tan^2\theta}=1$ and $\frac{x^2}{t^2+1}-\frac{y^2}{1-t^2}=1$ intersects each other orthogonally for all $\theta \in \left(0,\frac{\pi}{2}\right)$ and $t \in (0,1)$ → T

(C) $\frac{x^2}{4}+\frac{y^2}{3}=1$ and $\frac{x^2}{\cos^2\theta}-\frac{y^2}{\sin^2\theta}=1$ intersects each other orthogonally for all $\theta \in \left(0,\frac{\pi}{2}\right)$. → T

(D) $\frac{x^2}{4}+\frac{y^2}{3}=1$ and $\frac{x^2}{\sec^2\theta}-\frac{y^2}{\tan^2\theta}=1$ intersects each other orthogonally for all $\theta \in \left(0,\frac{\pi}{2}\right)$. → F

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16

JEE 1

$$E : \frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$$

$$H : \frac{x^2}{A^2} - \frac{y^2}{B^2} = 1$$

Confocal $\Rightarrow$ orthogonal ✓

$$b^2 = a^2(1-e^2)$$

$$b^2 = a^2 - a^2e^2$$

$$\boxed{a^2e^2 = a^2 - b^2}$$

$$B^2 = A^2(E^2 - 1)$$

$$\boxed{A^2E^2 = A^2 + B^2}$$

$$\boxed{a^2 - b^2 = A^2 + B^2}$$

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17

JEE 1

If $g(x) = x^2 + \frac{1}{x^2}$ and $f: [2, \infty) \to (-\infty, \infty)$,

such that $f(g(x)) = x^6 + \frac{1}{x^6}$, then $f'(x)$ equals-

(A) $x^5 + \frac{1}{x^5}$

(B) $3x^2 - 3$

(C) $5x^5 - \frac{6}{x^7}$

(D) $5x^5 - \frac{5}{x^5}$

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$$\left(x^2 + \frac{1}{x^2}\right)^3 = \left(x^6 + \frac{1}{x^6}\right) + 3\left(\cancel{x^2}\right)\left(\cancel{\frac{1}{x^2}}\right)\left(x^2 + \frac{1}{x^2}\right)$$

$$\left(x^2 + \frac{1}{x^2}\right)^3 - 3\left(x^2 + \frac{1}{x^2}\right) = x^6 + \frac{1}{x^6}$$

$$(g(x))^3 - 3(g(x)) = f(g(x))$$

$$f(x) = x^3 - 3x$$

$$\boxed{f'(x) = 3x^2 - 3}$$

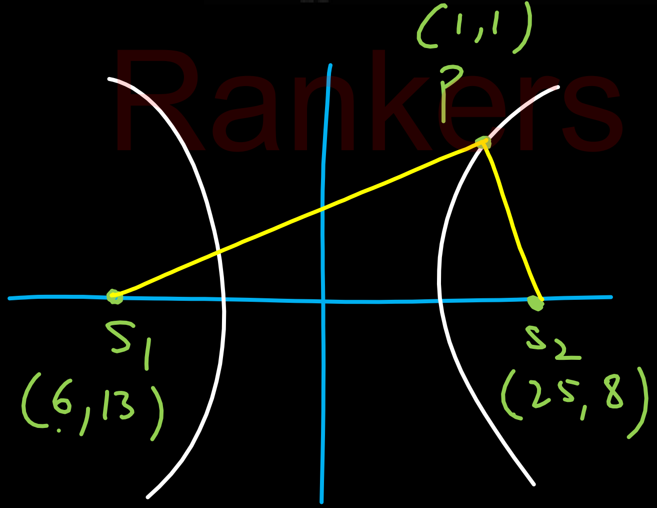
18

If (6,13) and (25,8) are the foci of a hyperbola passing through the point (1,1) then the eccentricity of the hyperbola is

(A) $\frac{\sqrt{386}}{38}$ (B) $\frac{\sqrt{386}}{25}$

(C) $\frac{\sqrt{386}}{13}$ (D) $\frac{\sqrt{386}}{12}$ ✓

$$\begin{cases} |PS_1 - PS_2| = 2a \\ S_1S_2 = 2ae \end{cases}$$



$$S_1S_2 = \sqrt{(19)^2 + (5)^2} = \sqrt{386}$$

$$PS_1 = \sqrt{25 + 144} = 13$$

$$PS_2 = \sqrt{24^2 + 7^2} = 25$$

$$|PS_1 - PS_2| = 12$$

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19

JEE 1

A line passing through point A(5,4,1) and parallel to the line $\frac{x}{2}=\frac{y}{1}=\frac{z}{2}$ meets the line $\frac{x-1}{2}=\frac{1-y}{-2}=\frac{z-2}{-3}$ in point B. The length of line segment joining mid point AB to point $\left(-2,\frac{3}{2},3\right)$ is

(A) 6 (B) 3

(C) 7 (D) 12

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L_1

L_2

$l_1 \equiv \frac{x-5}{2} = \frac{y-4}{1} = \frac{z-1}{2} = \lambda$

$l_2 \equiv \frac{x-1}{2} = \frac{y-1}{2} = \frac{z-2}{-3}$

$(2\lambda+5, \lambda+4, 2\lambda+1)$

$\underbrace{\frac{2\lambda+4}{2} = \frac{\lambda+3}{2}}$ $= \frac{2\lambda-1}{-3}$

$2\lambda+4=\lambda+3$

$\boxed{\lambda=-1}$

$$B \equiv (3, 3, -1)$$

$$A \equiv (5, 4, 1)$$

$$M \equiv \left(4, \frac{7}{2}, 0\right)$$

$$Q \equiv \left(-2, \frac{3}{2}, 3\right)$$

$$\sqrt{36+4+9} = 7$$

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20

JEE 1

The solution of differential equation $\frac{dy}{dx} = \frac{6x^2y}{2x^3+5y^4}$ is :

(A) $2x^3y^{-1} = \frac{5y^3}{3} + C$ (B) $2x^2y^{-1} = \frac{5}{3}y^3 + C$

(C) $2xy^{-1} = \frac{5}{3}y^3 + C$ (D) $2x^4y^{-1} = \frac{5}{3}y^3 + C$

M-1: LDE:

$$\frac{dy}{dx} = \frac{6x^2y}{2x^3+5y^4}$$

$$\frac{dx}{dy} = \frac{2x^3+5y^4}{6x^2y}$$

$$\frac{dx}{dy} = \frac{x}{3y} + \frac{5y^3}{6x^2}$$

$$3x^2\frac{dx}{dy} = \frac{x^3}{y} + \frac{5}{2}y^3$$

$$3x^2\frac{dx}{dy} - \frac{x^3}{y} = \frac{5}{2}y^3$$

$x^3 = z$

$$3x^2\frac{dx}{dy} = \frac{dz}{dy}$$

$$\frac{dz}{dy} + \left(\frac{-1}{y}\right)z = \frac{5y^3}{2}$$

$$IF = e^{\int -\frac{1}{y}dy}$$

Now proceed.

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M-2:

$$\frac{dy}{dx} = \frac{6x^2 y}{2x^3 + 5y^4}$$

$$2x^3\,dy + 5y^4\,dy = 6x^2 y\,dx$$

$$5y^4\,dy = 6x^2 y\,dx - 2x^3\,dy$$

$$\frac{5}{2}\frac{y^4\,dy}{y^2} = \frac{(y)(3x^2\,dx) - (x^3)(dy)}{y^2}$$

$$\frac{5}{2}\int y^2\,dy = \int d\left(\frac{x^3}{y}\right)$$

$$\frac{5}{2}\cdot\frac{y^3}{3} = \frac{x^3}{y} + C$$

$$\frac{5}{3}y^3 = 2x^3 y^{-1} + C'$$

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21

JEE 1

If M is absolute minimum value of

$f(x) = \cos\pi x + 10x + 3x^2 + x^3$, $\boxed{-2 \le x \le 3}$, find the value of

$\frac{-M}{5} = $ ______ 3

$$f'(x) = -\pi \sin\pi x + 10 + \underbrace{6x + 3x^2}_{3(x^2+2x+1)-3}$$

$$= \underbrace{-\pi \sin\pi x + 7}_{+ve} + \underbrace{3(x+1)^2}_{+ve}$$

> 0

$f(x)\uparrow \quad \therefore f_{min} = f(-2) = 1 - 20 + 12 - 8 = -15 = M$

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22

If $f(x) = \frac{x^3}{3} + 3x^2 + k^2x - 10$ is a many one function, find sum of all positive integral values of k.

3

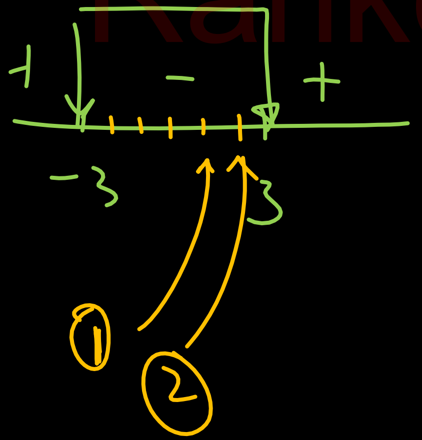
$f'(x) = \underbrace{x^2 + 6x + k^2}$

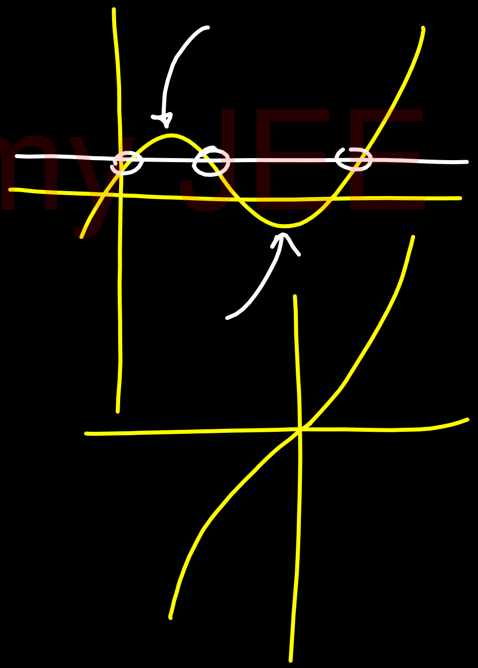
$D > 0$

$36 - 4k^2 > 0$

$9 - k^2 > 0$

$\boxed{k^2 - 9 < 0}$





JEE 1

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23

JEE1

The mean of 6 observations is 5 and their variance is 7. If four of the observations are 1,3,4 and 6, then the mean deviation from the mean of the data is α then value of 3α is :

$$\bar{x} = 5 = \frac{1+3+4+6+x+y}{6} \Rightarrow \boxed{x+y=16} \text{ — } (1)$$

$$\sigma^2 = 7 = \frac{1+9+16+36+x^2+y^2}{6} - (5)^2$$

$$32 \times 6 = 26+36+x^2+y^2 \Rightarrow \boxed{x^2+y^2=130} \text{ — } (2)$$

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JEE1

23

$$\begin{cases} x = 7 \\ y = 9 \end{cases}$$

$\{1, 3, 4, 6, 7, 9\}$; $\bar{x} = 5$

$$MD = \frac{\sum |x_i - \bar{x}|}{6}$$

$$\alpha = \frac{4+2+1+1+2+4}{6} = \frac{14}{6} = \frac{7}{3}$$

$3\alpha = 7$

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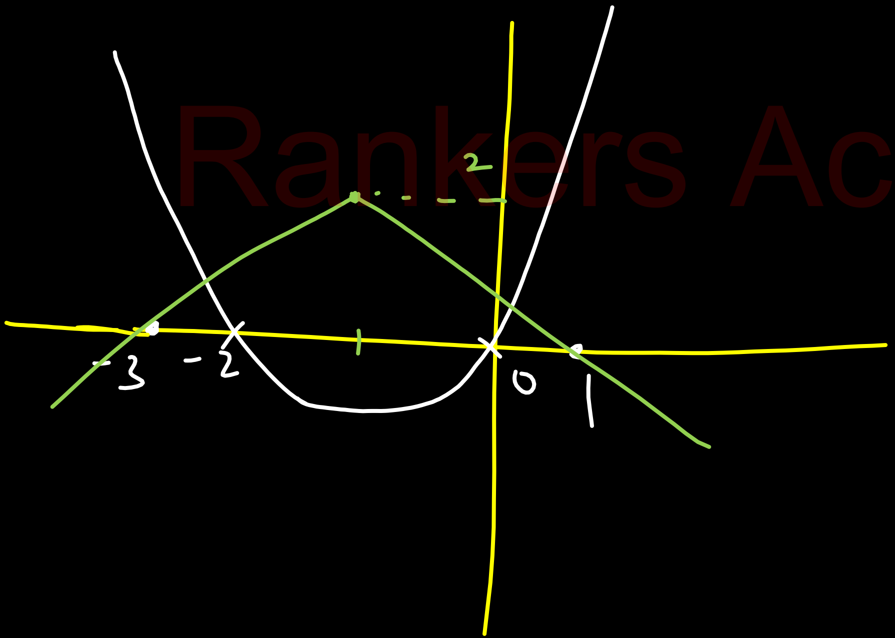
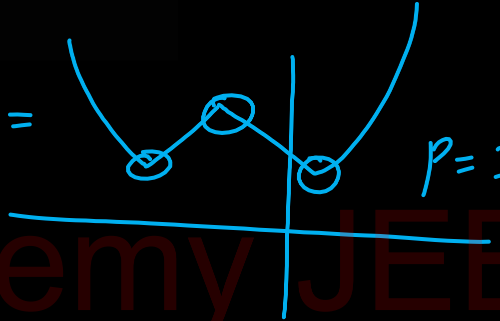
24

The number of points of non-differentiability of the function $f(x) = \max\{x^2 + 2x, 2 - |x + 1|\}$ is p and $g(x) = \min\{x^2 + 2x, 2 - |x + 1|\}$ is q, then the value of $(p + q)$ is

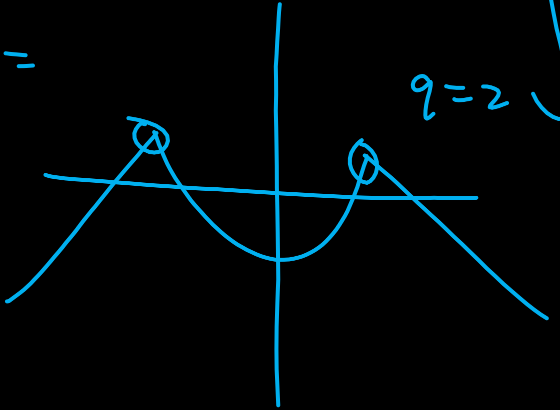


$f(x) =$



$p = 3$

$g(x) =$



$q = 2$

$p + q = 5$

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JEE 1

25

JEE 1

If $\int \frac{x^4+1}{x(x^2+1)^2}dx = a\ln|x| + \frac{b}{1+x^2} + C$, then $\lim_{x\to 0}\left(\frac{a\sin 10x + b\cos x - 1}{x}\right)$ is equal to (Where C is integration constant, a, b ∈ R)

$$\int \frac{x^4+1+2x^2-2x^2}{x(x^2+1)^2}dx$$

$$\int \frac{\cancel{(x^2+1)^2}}{x\cancel{(x^2+1)^2}} - \frac{2x^{\cancel{2}}}{\cancel{x}(x^2+1)^2}dx$$

$$\int \frac{1}{x}dx - \int \frac{2x\,dx}{(x^2+1)^2}$$

$$\ln x - \left(-\frac{1}{t}\right) + c$$

$$\ln x + \frac{1}{x^2+1} + c$$

$a=1$ & $b=1$

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$$\lim_{x\to 0} \frac{\sin 10x + \cos x - 1}{x}$$

$$\lim_{x\to 0} \frac{10\cos 10x - \sin x}{1}$$

10

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