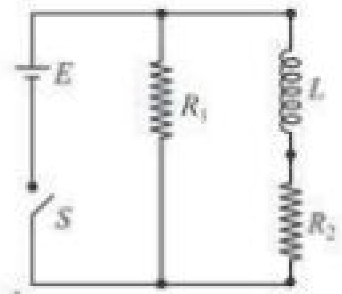
Physics

Q.1 An inductor of $L = 400\,mH$ and resistors of resistances $R_1 = 2\Omega$ and $R_2 = 2\Omega$ are connected to a battery of emf 12 V as s[illegible] internal resistance of the battery is $r =$ negligible. The switch [illegible] The potential drop across L as a function of time is



Option 1:
$6e^{-5t}V$

Option 2:
$\frac{12}{t}e^{-3t}V$

Option 3:
$6(1-e^{-t/0.2})V$

Option 4:
$12e^{-5t}V$

Correct Answer:
$12e^{-5t}V$

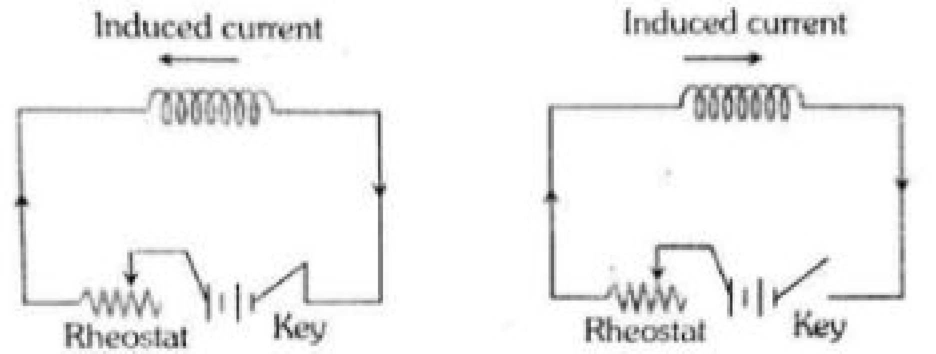
Solution:

As we learnt in

Self Inductance -

An emf is induced in the coil or the circuit which oppose the change that causes it. Which is also known back emf.

- wherein



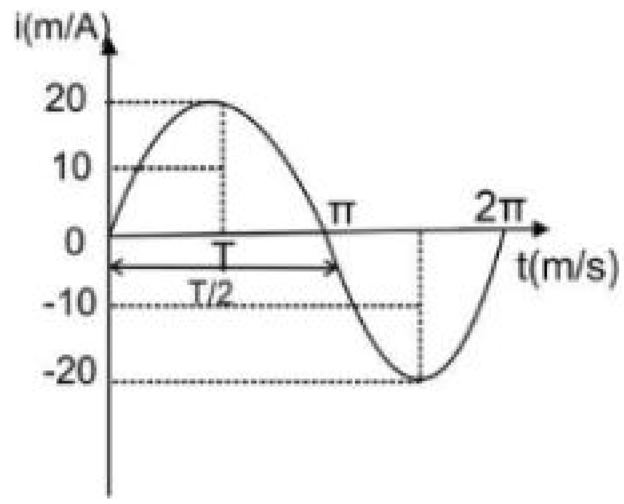
(A) Main current increasing **(B)** Main current decreasing

time constant of the given circuit $T = \frac{L}{R_2} = \frac{400mh}{2} = 0.2$ sec

$\therefore$ potential drop is

$$\xi = \varepsilon_0 \cdot e^{-\frac{t}{T}}$$
$$\xi = 12 \cdot e^{-5t}$$

Q. 2



The rms current in above g is

Option 1:
20mA

Option 2:
14.14mA

Option 3:
0

Option 4:
None

Correct Answer:
14.14mA

Solution:

As we learnt

Peak current / voltage -

Maximum value of alternating quantity

$V_0 \rightarrow$ peak voltage

$I_0 \rightarrow$ peak current

- wherein

A $t = \frac{T}{4}$ for beginning

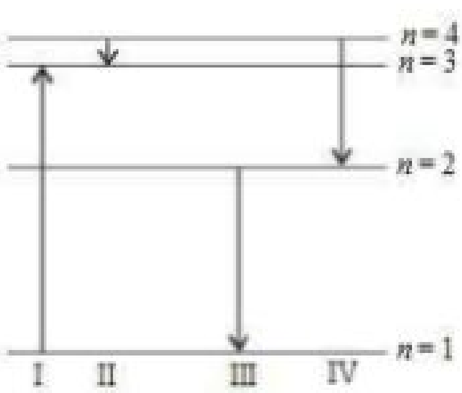
rms value $i_{rms} = \frac{i_0}{\sqrt{2}}$

From given g peak current $i_0 = 20mA$

$\Rightarrow i_{rms} = \frac{20}{\sqrt{2}}$

$\Rightarrow i_{rms} = 14.14mA$

Q.3 The diagram shows the energy levels for an electron in a
shown represents the emission of a photon with the mos



Option 1:

i

Option 2:

II

Option 3:
III

Option 4:
IV

Correct Answer:
III

Solution:

As we learnt in

Energy emitted due to transition of electron -

$$\Delta E = Rhcz^2 \left(\frac{1}{{n_f}^2} - \frac{1}{{n_i}^2} \right)$$

$$\frac{1}{\lambda} = Rz^2 \left(\frac{-1}{{n_i}^2} + \frac{1}{{n_f}^2} \right)$$

- wherein

$R = Rhydberg\, constant$

$n_i = initial\, state$
$n_f = final\, state$

Highest di erence of energy is between n = 1 and n = 3.

According to $\Delta E = E_0 z^2 \left(\frac{1}{n_i^2} - \frac{1}{n_f^2} \right)$. Correct option is III. Since I is absorpt

Correct option is 3.

Q.4 Both the nucleus and the atom of some element are in t states. They get de-excited by emitting photons of wave λ_N, λ_A respectively. The ratio λ_N/λ_A is closest to :

Option 1:
10^{-6}

Option 2:
10

Option 3:
10^{-10}

Option 4:
10^{-1}

Correct Answer:
10^{-6}

Solution:

As we have learned

γ decay -

γ ray emitted when nucleus undergoes radio active decay left

- wherein

After emission of α, β particle the product nucleus formed in excited s

nucleus emit radition (like γ rays) of order of 0.1 $\AA$

And energy of γ rays is in order of Mev.

Similary for hydrogen like atoms

$$E_n = 13.6 * \frac{Z^2}{n^2} ev$$

that energy of hydrogen like atoms is in order of ev.

or atom emits radiation of order of $10^5 \AA$

ratio $\frac{\lambda_N}{\lambda_a} = \frac{0.1}{10^5} = 10^{-6}$

or $\frac{\lambda_N}{\lambda_a} = \frac{E_a}{E_N} = \frac{1ev}{1Mev} = \frac{1}{10^6} = 10^{-6}$

Q.5 A monomade optical fibre has refractive index of core and μ_1 and μ_2 placed in a medium having μ_0. Which one of the following is accepted angle (θ_a) for it ? (Note : Acceptance angle (θ_a) is the maximum ang imcidence for which transmission of signals may take pl

Option 1:
$\sin\theta_a = \frac{\sqrt{\mu_1^2 - \mu_2^2}}{\mu_0}$

Option 2:
$\cos\theta_a = \frac{\sqrt{\mu_1^2 - \mu_2^2}}{\mu_0}$

Option 3:

$$\tan\theta_a = \frac{\sqrt{\mu_1^2 - \mu_2^2}}{\mu_0}$$

Option 4:

none

Correct Answer:

$$\sin\theta_a = \frac{\sqrt{\mu_1^2 - \mu_2^2}}{\mu_0}$$

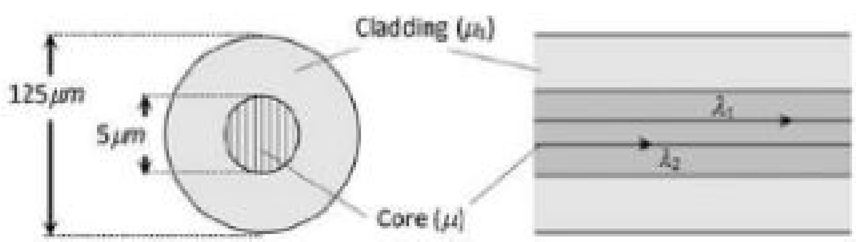
Solution:

As we have learned

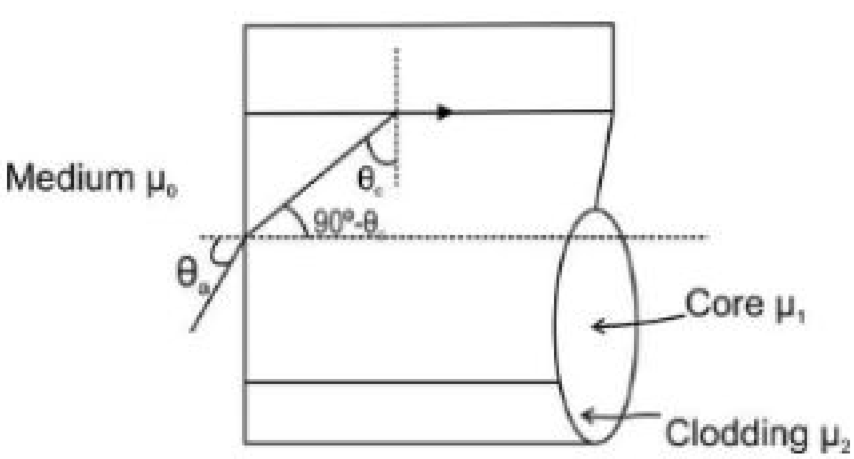
Acceptance angle (θa) -

The value of maximum angle of incidence with the axis of fibre in air for which all the incident light is totally reflected is known as Acceptance angle .

- wherein



$$\sin\Theta_a = \frac{\sqrt{{\mu_1}^2 - {\mu_2}^2}}{\mu_0}$$



By snell's law $\mu_0 \sin\theta_a = \mu_1 \sin(90^\circ - \theta_c)$

$$= \mu_1 \cos\theta_c$$

$$= \mu_1\sqrt{1 - \sin^2\theta_c} \text{..........}(1)$$

By applying snells law at core cladding interface ,

$$\mu_1 \sin\theta_c = \mu_2 \sin 90^\circ$$

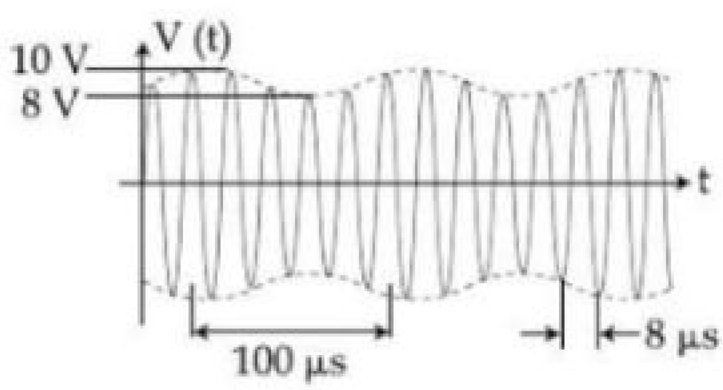
$$\Rightarrow \sin\theta_c = \mu_2/\mu_1 ....(2)$$

By putting value of $\Rightarrow \sin\theta_c$ from equation (2) to (1)

$$\mu_0 \sin\theta_a = \mu_1 \sqrt{1 - \left(\frac{\mu_2}{\mu_1}\right)^2}$$

$$\Rightarrow \sin\theta_a = \frac{\sqrt{\mu_1^2 - \mu_2^2}}{\mu_0}$$

Q.6 An amplitude modulated signal is plotted below :



Which one of the following best describes the above sig

Option 1:
$(9 + sin(4\pi \times 10^4 t))\ sin\ (5\pi \times 10^5 t)\ V$

Option 2:
$(1 + 9sin(2\pi \times 10^4 t))\ sin\ (2.5\pi \times 10^5 t)\ V$

Option 3:
$(9 + sin(2.5\pi \times 10^5 t))\ sin\ (2\pi \times 10^4 t)\ V$

Option 4:
$(9 + sin(2\pi \times 10^4 t))\ sin\ (2.5\pi \times 10^5 t)\ V$

Correct Answer:

$(9 + sin(2\pi \times 10^4 t))\ sin\left(2.5\pi \times 10^5 t\right) V$

Solution:

Voltage equation for AM wave -

$$e_c = E_c \cos \omega_c t$$

$$e_m = E_m \sin \omega_m t$$

Resultant Modulated wave

$$e = (E_c + e_m \sin \omega_m t) \cdot \sin \omega_c t$$

From the graph

$E_{min} = 8v$ and $E_{max} = 10v$

$$E_C = \frac{E_{MAX} + E_{MIN}}{2}$$

and

$$T_s = Time\ period\ of\ signal\ wave = 100 \mu s$$

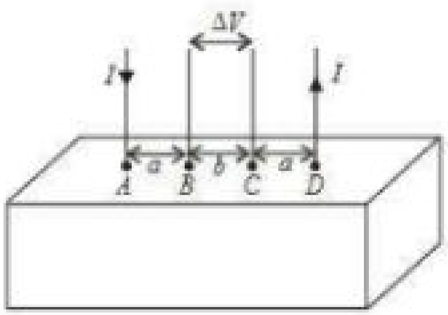
$$T_c = Time\ period\ of\ carrier\ \ wave = 8 \mu s$$

So signal equation is

$$= \left[9 \pm 1 \sin\left(\frac{2\pi t}{T_s}\right) \sin\left(\frac{2\pi t}{T_c}\right)\right] = \left[9 \pm \sin\left(2\pi \times 10^4 t\right) \sin\left(2.5\pi \times 10^5 t\right)\right]$$

Q.7 ΔV measured between B and C

Directions : Consider a block of conducting material of
Current I enters at A and leaves from D . We apply s
ΔV developed between B and C The calculation is done i



(i) Take current I entering from A and assume it t
in the block.

(ii) Calculate eld E(r) at distance $E = \rho j$ Where ... is the i
current per unit area at r

(iii) From the r dependence of E (r) obtain the poter

(iv) Repeat (i),(ii) and (iii) for current I leaving D a

Option 1:

$$\frac{\rho I}{2\pi(a-b)}$$

Option 2:

$$\frac{\rho I}{\pi a}-\frac{\rho I}{\pi(a+b)}$$

Option 3:

$$\frac{\rho I}{a}-\frac{\rho I}{(a+b)}$$

Option 4:

$$\frac{\rho I}{2\pi a}-\frac{\rho I}{2\pi(a+b)}$$

Correct Answer:

$$\frac{\rho I}{2\pi a}-\frac{\rho I}{2\pi(a+b)}$$

Solution:

Miniature form of Ohms Law -

$$\vec{J} = \sigma \vec{E}$$

$$\vec{J} = \frac{\vec{E}}{\rho}$$

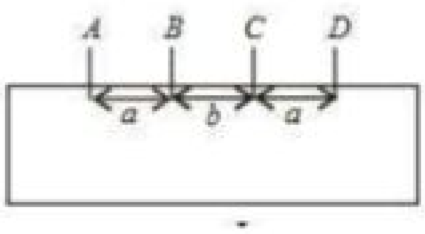
Where $\sigma \rightarrow$ Conductivity

$\rho \rightarrow$ Resistivity

Both J and E will have the same direction.

-

Current is spread over area $2\pi r^2$. Thence current is a surface current.



Current density,

$$j = \frac{I}{2\pi r^2}$$

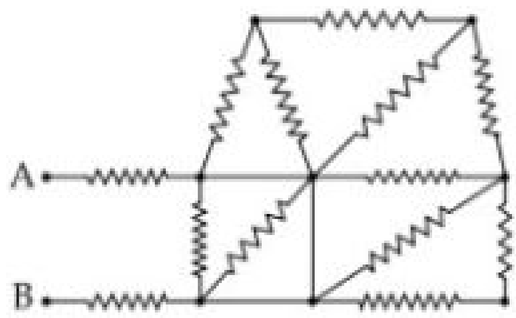
$$E = \frac{I\rho}{2\pi r^2}$$

$$V_B - V_C = \Delta V = \int_{a+b}^{a} -E dr$$

$$\Rightarrow \Delta V = \frac{-I\rho}{2\pi} \int_{a+b}^{a} \frac{1}{r^2} dr = \frac{-I\rho}{2\pi} \left[-\frac{1}{r} \right]_{a+b}^{a}$$

$$\Rightarrow \Delta V = \frac{I\rho}{2\pi} \left[\frac{1}{a} - \frac{1}{a+b} \right]$$

Q.8 In the given circuit all resistances are of value R ohm each. The equivalent resistance between A and B is :



Option 1:
2 R

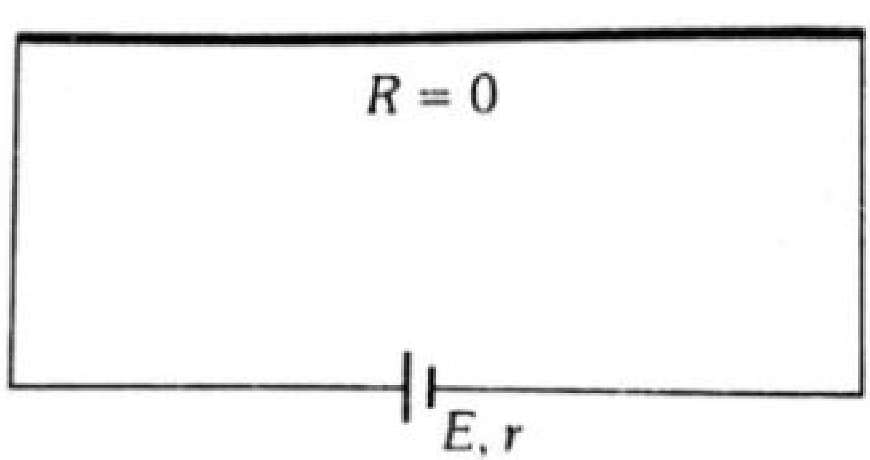
Option 2:
3 R

Option 3:
$\frac{5R}{3}$

Option 4:
$\frac{5R}{2}$

Correct Answer:
2 R

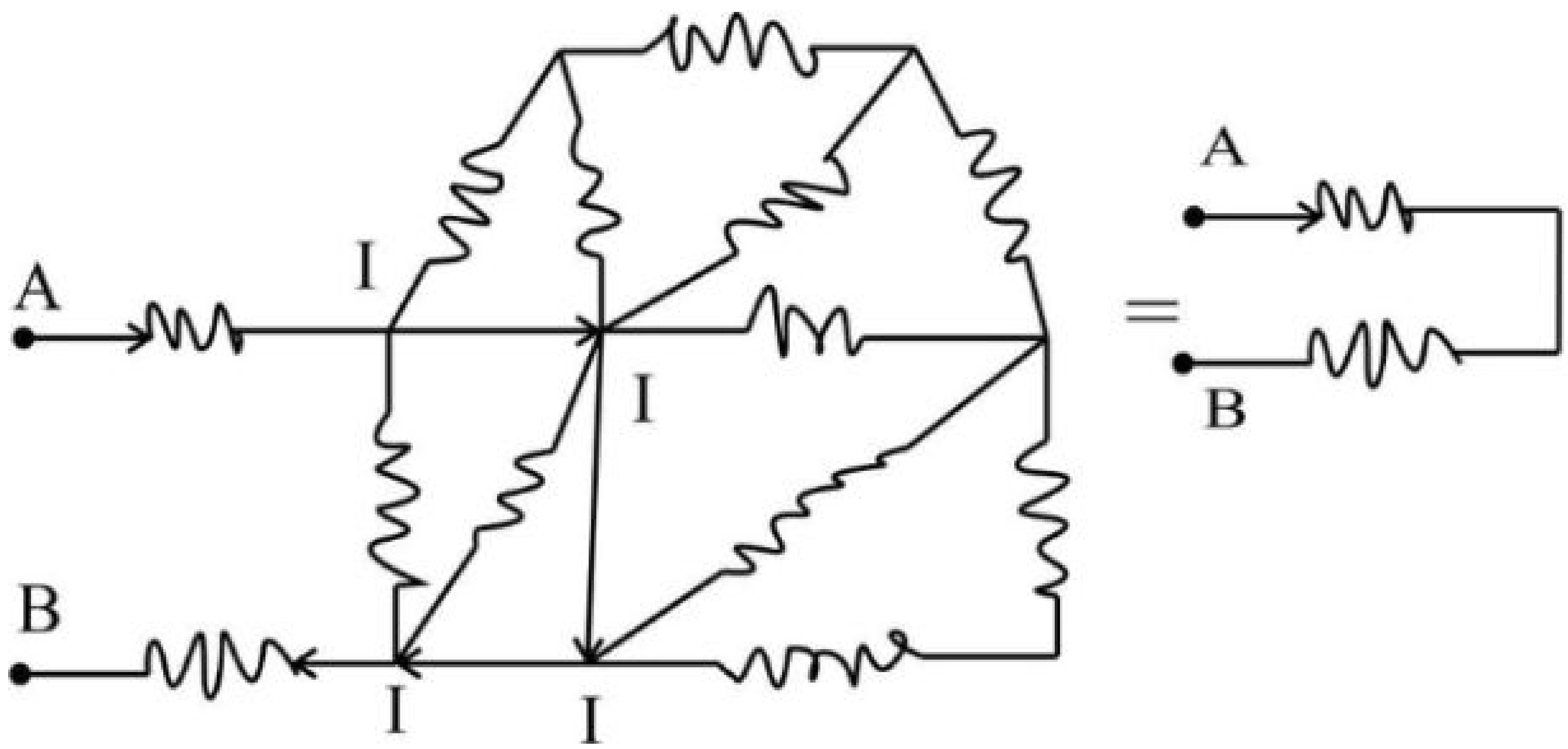
Solution:
Short circuit



- Two terminals of a cell are joined together by a thick conduct

- Maximum current $i = \frac{E}{r}$
- $V = 0$

-



When we connect a battery between A & B

No current will pass through any resistance other than R & R

$R_{eq} = 2R$

Q.9 A beam of light has two wave lengths 4972 Å and 6216 Å
Wm-2 equally distributed among the two wavelengths. T
of 1 cm2 of a clean metallic surface of work function 2.3
light by re ection and that each capable photon ejects o
photoelectrons liberated in 2s is approximately :

Option 1:
6×10^{11}

Option 2:
9×10^{11}

Option 3:
11×10^{11}

Option 4:
15×10^{11}

Correct Answer:
9×10^{11}

Solution:

$$\lambda_1 = 4972A^\circ, \lambda_2 = 6216A^\circ$$
$$I = 3.6 \times 10^{-3} w/m^2$$

Intensity with each wavelength = $1.8 \times 10^{-3} W/m^2$

the energy of a photon is given by

$$E = \frac{hc}{\lambda} = \frac{6.62 \times 10^{-34} \times 3 \times 10^8}{\lambda}$$

$$E = 12.4 \times 10^3/\lambda$$

$$E_1 = 12.4 \times 10^3/\lambda_1 = 2.493eV = 3.98 \times 10^{-19} J = 2.48\ eV$$

$$E_2 = 12.4 \times 10^3/\lambda_2 = 3.189 \times 10^{-19} J = (1.99eV)$$

And work function is

$$\phi = 2.3eV$$

Since only $E_1 > \phi$

So only photons corresponding λ_1 will be able to eject photoelectrons

So $N/sec = \frac{P}{E} = \frac{IA}{E}$

here $A = 1\ cm^2$

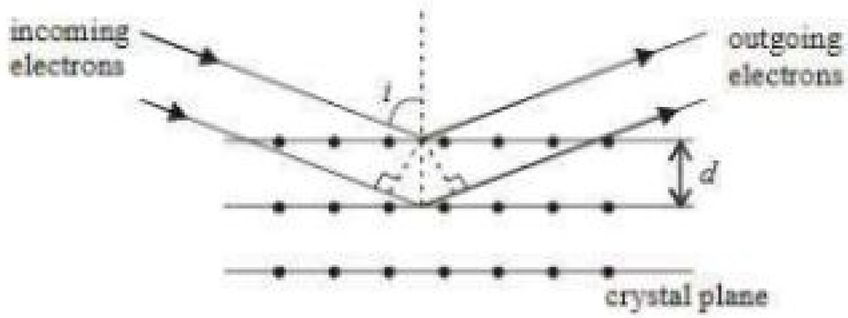
$$N/sec = \frac{1.8 \times 10^{-3}}{3.984 \times 10^{-19} \times 10^4} = 0.45 \times 10^{12}$$

In 2 sec N will be

N = 9×10^{11}

Q. 10 Question is based on the following paragraph.

Wave property of electrons implies that they will show c
Germer demonstrated this by di racting electrons from c
di raction from a crystal is obtained by requiring that e
planes of atoms in a crystal interfere constructively (se



Question : Electrons accelerated by potential V are diffracted from a crystal. If
$d = 1\,\mathring{A}\ and\ i = 30^{\circ}, V$ should be about
$(h = 6.6 \times 10^{-34}\ Js, m_e = 9.1 \times 10^{-31} kg, e = 1.6 \times 10^{-19} C)$

Correct Answer:
50

Solution:

As we learnt in

Bragg's formula -

$2d \sin \Theta = n\lambda$

- wherein

$d - distance\ between\ diffracting\ planes$

Condition of constructive interference is $2d\ sin\theta = n\lambda$

$\theta = 90^{o} - i = 60^{o}$

Take n = 1

So $\lambda = 2d\sin(60^0)$

& $\lambda = \dfrac{h}{\sqrt{2mE}} = \dfrac{h}{\sqrt{2meV}}$

$\therefore \quad \dfrac{h}{\sqrt{2meV}} = \dfrac{2 \times 1\mathring{A} \times \sqrt{3}}{2}$

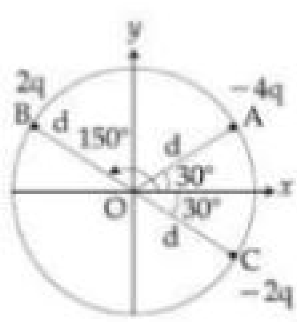
Square both side

$$\frac{h^2}{2meV} = 3 \times 10^{-20}$$

$$V = \frac{(6.62 \times 10^{-34})^2}{2 \times 9.1 \times 10^{-31} \times 1.6 \times 10^{-19} \times 3 \times 10^{-20}} = \frac{43.82 \times 10^{-68}}{87.36 \times 10^{-70}} = 50V$$

Correct option is 1.

Q.11 Three charged particles A, B and C with charges $-4q, 2q$ and $-2q$ are present on the circumference of a circle of radius d. The charged particles formed an equilateral triangle as shown in figure. Electr



Option 1:
$\dfrac{\sqrt{3}q}{4\pi\epsilon_0 d^2}$

Option 2:
$\dfrac{3\sqrt{3}q}{4\pi\epsilon_0 d^2}$

Option 3:
$\dfrac{\sqrt{3}q}{\pi\epsilon_0 d^2}$

Option 4:
$\dfrac{2\sqrt{3}q}{\pi\epsilon_0 d^2}$

Correct Answer:

$$\frac{\sqrt{3}q}{\pi\epsilon_0 d^2}$$

Solution:

Let E1 be the resultant electric eld due tics ch atrhgee d2iq eacntdo-n 2oq

$$E_1 = \frac{k2q}{d^2} + \frac{k2q}{d^2} = \frac{k4q}{d^2}$$

E2 due to -4q is in the direction of -4q and magnitude is giv

$$E_2 = \frac{k4q}{d^2}$$

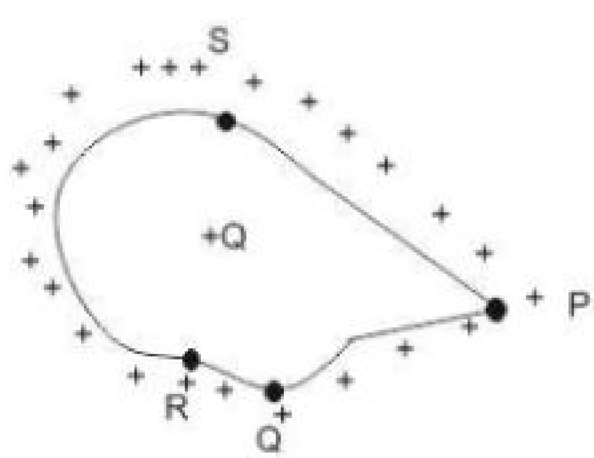
The net electric eld in the x-direction is

$$E_x = E_1 cos30 + E_2 cos30 = \frac{\sqrt{3}}{2} \times 2 \times \frac{4q}{4\pi\epsilon_0 d^2}$$

$$E_x = \sqrt{3}\frac{q}{\pi\epsilon_0 d^2}$$

So the correct option is 3.

Q.12 A shown in the gure charge +Q is given to a irregular s charge density will be at the point



Option 1:

P

Option 2:
Q

Option 3:
R

Option 4:
S

Correct Answer:
P

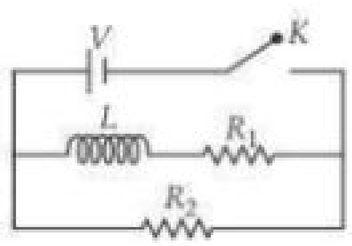
Solution:
As we learn

Charge distribution -

Charge are classi eds according to their shape and size of the

The charge density will be maximum where the radius of curva

Q. 13 In the circuit shown below, the key K is closed at $t=0$. The current through the b



Option 1:
$$\frac{V(R_1+R_2)}{R_1R_2} at\ t=0\ and\ \frac{V}{R_2} at\ t=\infty$$

Option 2:
$$\frac{VR_1R_2}{\sqrt{R_1^2+R_2^2}}\ at\ t=0\ and\ \frac{V}{R_2}\ at\ t=\infty$$

Option 3:
$$\frac{V}{R_2}\ at\ t=0\ and\ \frac{V(R_1+R_2)}{R_1R_2} at\ t=\infty$$

Option 4:
$$\frac{V}{R_2} at\ t=0\ and\ \frac{VR_1R_2}{\sqrt{R_1^2+R_2^2}}\ at\ t=\infty$$

Correct Answer:

$$\frac{V}{R_2}\ at\ t = 0\ and\ \frac{V(R_1 + R_2)}{R_1 R_2} at\ t = \infty$$

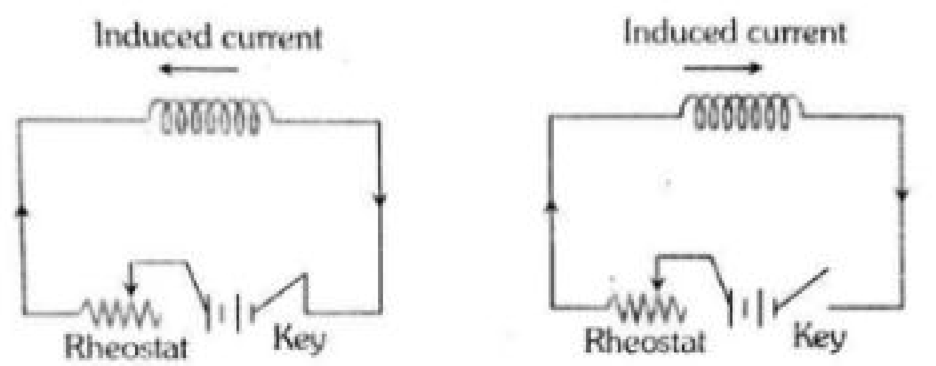
Solution:

As we learnt in

Self Inductance -

An emf is induced in the coil or the circuit which oppose the change that causes it. Which is also known back emf.

- wherein



(A) Main current increasing **(B)** Main current decreasing

at t=0, there is no current through inductor

$\therefore$ I = 0

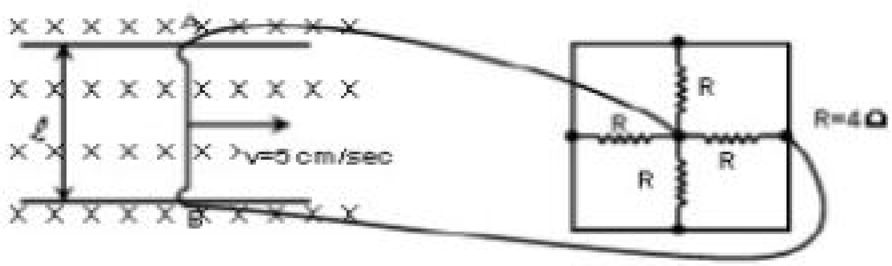
as $t \rightarrow \infty$

$$I = \frac{V}{r_{eq}}$$

$$= \frac{V/R_1 R_2}{R_1 + R_2}$$

$$= \frac{V(R_1 + R_2)}{R_1 + R_2}$$

Q. 14 A conductor of length 5 cm, and resistance 2Ω is moving
velocity of 5 cm/s in a magnetic eld of intensity 3 tesla
connected to a circuit as shown, by two lead wires of al
current owing in it is



Option 1:
0.25 A

Option 2:
2.5 Amp

Option 3:
2.5 mA

Option 4:
0.25 ×104 amp

Correct Answer:
2.5 mA

Solution:

As we learnt in

Induced Current -

$$I = \frac{\varepsilon}{R} = \frac{Blv}{R}$$

-

All the 4 resistance are in parallel

$$=> Req = \frac{R}{4} = 1\Omega$$

Re stance of coωnductor = 2

1ω and ω 2re in series

$$\therefore R_{eq} = 3\Omega$$

Emf induced across conductor = Blv

$= 3 \times 5 \times 10^{-2} \times 5 \times 10^{-2}$

$= 75 \times 10^{-4} V$

$\therefore current\ flowing = \frac{\varepsilon}{R_{eq}} = \frac{7.5mV}{3} A = 2.5mA$

Q. 15 An EM wave from air enters a medium. The electric elds $\vec{E_1} = E_{01}\hat{x}cos\left[2\pi v\left(\frac{z}{c} - t\right)\right]$ in air and $\vec{E_2} = E_{02}\hat{x}cos[k(2z - ct)]$ in medium, wher the wave number k and frequency v refer to their values magnetic ϵ_{r1} and ϵ_{r2} refer to relative permittivities of air and m of the following options is correct ?

Option 1:
$\frac{\epsilon_{r_1}}{\epsilon_{r_2}} = \frac{1}{2}$

Option 2:
$\frac{\epsilon_{r_1}}{\epsilon_{r_2}} = 4$

Option 3:
$\frac{\epsilon_{r_1}}{\epsilon_{r_2}} = 2$

Option 4:
$\frac{\epsilon_{r_1}}{\epsilon_{r_2}} = \frac{1}{4}$

Correct Answer:
$\frac{\epsilon_{r_1}}{\epsilon_{r_2}} = \frac{1}{4}$

Solution:

As we learnt that

Wave Equation -

$E = E_o Sin w(t - \frac{x}{c})$

E is in y-z plane

- wherein

E - Electric eld at (x,t)

E0 - Electric eld amplitude

ω= Angular frequency

c= Speed of light in vacuum

Wave equation is given by

$$E = E_o Sin w(t - \frac{x}{c})$$

$$E_x = E\sin{(\omega t - kx)}$$

$$K = \frac{\omega}{C}$$

Speed of light formula in vacuum -

$$c = \frac{1}{\sqrt{\mu_o \epsilon_o}}$$

c = 2.99783 $\times 10^{8}$ m/s

- wherein

c = Speed of light in vacuum

μ_o = Permeability of vacuum

ϵ_o = Permittivity of vacuum

Speed of light formula in medium-

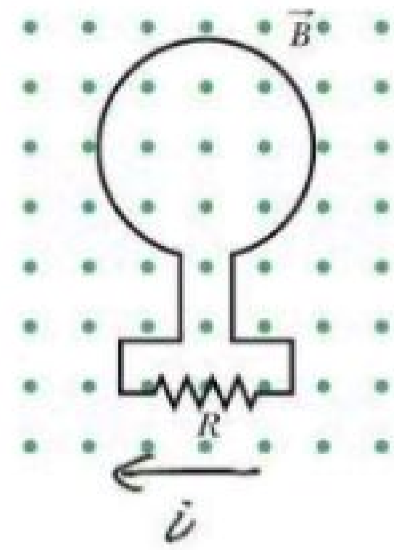
$$c = \frac{1}{\sqrt{\mu_o \mu_r \epsilon_o \epsilon_r}}$$

$\frac{V}{C} = \frac{1}{2}$ (where v= speed in medium and c=speed of light in air)

For non magnetic medium; $\mu = 1$

$$\frac{V}{C} = \sqrt{\frac{\epsilon_{r1}}{\epsilon r_2}} = \frac{1}{2} or \frac{\epsilon_{r1}}{\epsilon_{r2}} = \frac{1}{4}$$

Q. 16 The magnetic ux through the loop shown in Fig. increa
$\phi_B = 6.0t^2 + 7.0t$, where ϕ_B is in milliwebers and t is in seconds. V
of the emf induced in the loop when t = 2.0 s?



Option 1:
$-(1.6 \times 10^{-2})\ \frac{wb}{s}$

Option 2:
$(-3.1 \times 10^{-3})\ \frac{Wb}{s}$

Option 3:
$-(1.6 \times 10^{-3})\ \frac{wb}{s}$

Option 4:
$-(3.1 \times 10^{-2})\ \frac{wb}{s}$

Correct Answer:
$-(3.1 \times 10^{-2})\ \frac{wb}{s}$

Solution:

Maxwell's equations -

Maxwell's equations

The four Maxwell's equations and Lorentz force law together c
electromagnetism. The Maxwell's equations are:

1. $\oint \mathbf{E} \cdot d\mathbf{A} = Q/\varepsilon_0$ (Gauss's Law for electricity)

2. $\oint \mathbf{B} \cdot d\mathbf{A} = 0$ (Gauss's Law for magnetism)

3. $\oint \mathbf{E} \cdot d\mathbf{l} = \frac{-d\phi_B}{dt}$ (Faraday's Law)

4. $\oint \mathbf{B} \cdot d\mathbf{l} = \mu_0 i_c + \mu_0 \varepsilon_0 \frac{d\phi_E}{dt}$ (Ampere-Maxwell Law)

- As we know from faraday's law :

$$\varepsilon_{ind} = \frac{-d\phi_B}{dt}$$

$$\frac{d\phi_B}{dt} = \frac{d}{dt}(6t^2 + 7t) = (12t + 7)\ \frac{mWb}{s}$$

$$= (12t + 7) \times 10^{-3}\ \frac{Wb}{s}$$

At t=2 sec,

$$\varepsilon_{ind} = \frac{-d\phi_B}{dt} = -31 \times 10^{-3}\ \frac{Wb}{s}$$

Therefore $\varepsilon_{ind} = -3.1 \times 10^{-2}\ \frac{Wb}{s}$

Correct option is (4).

Q.17 If a dipole is slightly displaced from its stable equilbriu
is true

1. It will executes angular SHM
2. Time period of oscillation is $T = \frac{1}{2\pi}\sqrt{\frac{I}{PE}}$

Option 1:
only 1

Option 2:
only 2

Option 3:
Both 1 and 2

Option 4:
None of above

Correct Answer:
only 1

Solution:
As we learn

Oscillation of dipole -

$$T = 2\pi\sqrt{\frac{I}{PE}}$$

- wherein

I - Moment of Inertia of dipole.

It will be accurate SHM of time period

$$T = 2\pi\sqrt{\frac{I}{PE}}$$

Q.18 A particle having charge Q and mass m is rest at A and i
potential di erence between the point A and point B is de
ΔV as:

Option 1:
ΔV

Option 2:
$\sqrt{\Delta V}$

Option 3:
ΔV^2

Option 4:
$\frac{1}{\Delta V}$

Correct Answer:
$\sqrt{\Delta V}$

Solution:
As we learn

when Charged Particle at rest in uniform eld -

Velocity -

$$v=\frac{QEt}{m}=\sqrt{\frac{2Q\Delta V}{m}}$$

- wherein

$\Delta V=$ Potential di erence.

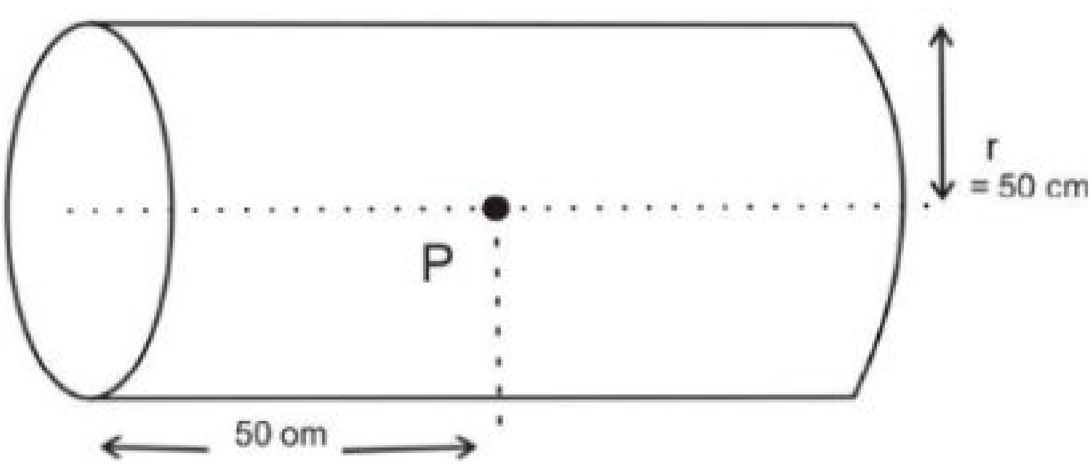
$$\Delta KE = workdone$$

$$\frac{1}{2}mv^2=Q\Delta V$$

$$v=\sqrt{\frac{2Q\Delta V}{m}}$$

$$v\propto\sqrt{\Delta V}$$

Q. 19 For a nite solenoid of length 100 cm , no. of turns 50 a
at point P of given diagram will be equal to



Option 1:
1 5 0 μ_0

Option 2:
1 2 5 μ_0

Option 3:
$125\sqrt{2}\mu_0$

Option 4:
$\frac{125}{\sqrt{2}}\mu_0$

Correct Answer:
$125\sqrt{2}\mu_0$

Solution:
As we learnt ,

Magnetic eld in nite length solenoid -

$$B = \frac{\mu o}{4\pi}(2\pi n)(Sin\alpha + Sin\beta) - n = \frac{N}{l}$$

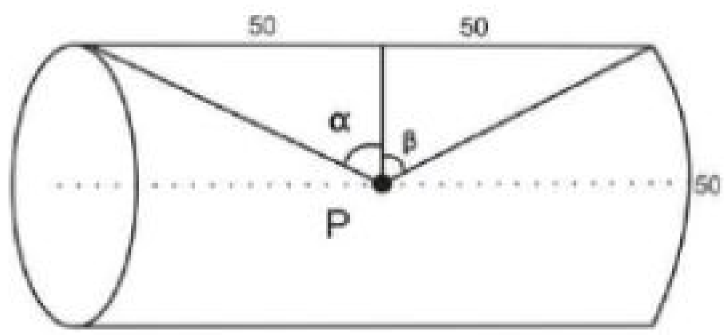
N =total number of turns

-

For a nite length solenoid -

$$B = \frac{\mu o}{4\pi}(2\pi n)(Sin\alpha + Sin\beta) \qquad \alpha = \beta = 45^o$$

$$= B = \frac{\mu o}{4\pi}(2\pi \times 50 \times 5)\left[\frac{1}{\sqrt{2}} + \frac{1}{\sqrt{2}}\right]$$



$$B = 125\sqrt{2}\mu_0$$

Q.20 A long straight wire of radius r carries a current i. The the crossection. The ratio of the magnetic eld at $\frac{R}{3}$ and $\frac{3}{2}$ is

Option 1:
2

Option 2:
$\frac{1}{2}$

Option 3:
1

Option 4:
$\frac{2}{9}$

Correct Answer:
$\frac{1}{2}$

Solution:
Magnetic eld inside $\frac{R}{3}$ is a cylinder at

$$B_1 = \frac{M_0 i(\frac{r}{3})}{2\pi r^2} = \frac{M_0 i}{6\pi r}$$

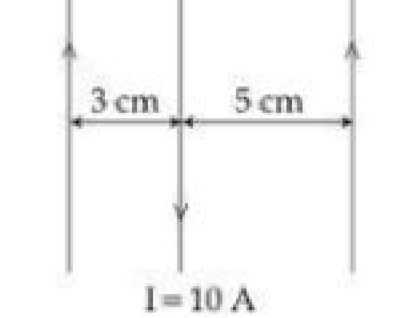
Magnetic eld $\frac{3}{2}r$ outside is at

$$B_2 = \frac{M_0 i}{2\pi \frac{3}{2} r} = \frac{2M_0 i}{6\pi r}$$

So,

$$\frac{B_1}{B_2} = \frac{1}{2}$$

Q. 21 Three straight parallel current carrying conductors are
experienced by the middle conductor of length 25 cm is



Option 1:
3×10^{-4} N toward right

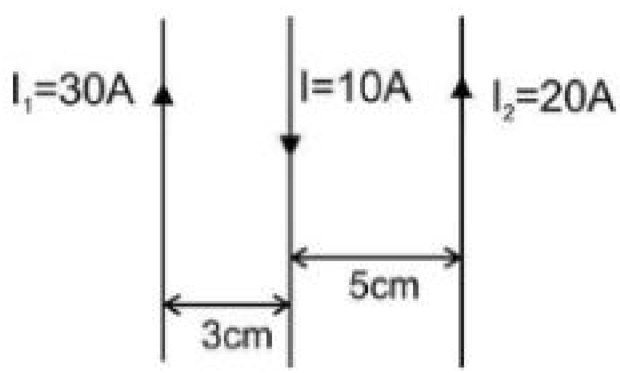
Option 2:
6×10^{-4} N toward left

Option 3:
9×10^{-4} N toward left

Option 4:
Zero

Correct Answer:
3×10^{-4} N toward right

Solution:



Force due to wire one

$$F_1 = \frac{\mu_0 I_1 I_2}{2\pi r_1} l = \frac{2 \times 10^{-7} \times 30 \times 10}{3 \times 10^{-2}} \times 25 \times 10^{-2} = 5 \times 10^{-4} \text{ towards right}$$

Force due to wire two

$$F_2 = \frac{\mu_0 I I_2}{2\pi r_2} l = \frac{2 \times 10^{-7} \times 20 \times 10}{5 \times 10^{-2}} \times 25 \times 10^{-2} = 2 \times 10^{-4} \text{ towards left}$$

Net force $= 3 \times 10^{-4}$ *towards right*

Q. 22 An electron exprience no de ection if subjected to an el
$6.4 \times 10^4 V/m$ *and a magnetic field of* $1.6 \times 10^{-3} wb/m^2$

ELectric eld , magnetic eld and velocity of electron ar
value of v is

Option 1:
$4 \times 10^7 m/s$

Option 2:
$2 \times 10^7 m/s$

Option 3:
$8 \times 10^5 m/s$

Option 4:
$6 \times 10^6 m/s$

Correct Answer:
$4 \times 10^7 m/s$

Solution:

As we have learned

Magnetic eld If V(vector), E (vector) and B (vector) are mutua

Fe=Fm

$$V = \frac{E}{B}$$

-

$$E_m = E_e$$

$$Bev = E_e$$

$$v = E/B \Rightarrow \frac{6.4 \times 10^4}{1.6 \times 10^{-3}}$$

$$v = 4 \times 10^7 m/s$$

Q. 23 In the nuclear ssion reaction,

$^2_1H + ^3_1H \rightarrow ^4_2He + n$ given that the repulsive potential energy b $\sim 7.7 \times 10^{-14} J$ the temperature at which the gases must be reaction is nearly

[Boltzmann's constant $k = 1.38 \times 10^{-23} J/K$]

Option 1:
$10^7 K$

Option 2:
$10^5 K$

Option 3:
$10^3 K$

Option 4:
$10^9 K$

Correct Answer:
$10^9 K$

Solution:

As we learnt in

Nuclear ssion -

e.g $^{236}_{92}U \rightarrow ^{137}_{53}I + ^{97}_{39}Y + 2n$

$Q\ value$

$= [(M_U + M_n) - (M_I + M_Y + 2M_n)].C^2$

- wherein

In nuclear ssion neutron trigger the reaction & in the proces

At temperature T, the $\frac{3}{2}kT$ kinetic energy is

$\frac{3}{2}KT = 7.7 \times 10^{-14}$

$T = \frac{7.7 \times 2 \times 10^{-14}}{3 \times 1.38 \times 10^{-23}} = 3.7 \times 10^9 K$

Correct option is 4.

Q. 24 In a radioactive decay chain, the initial nucleus is $^{232}_{90}Th$. At the end there are 6 particles β and 4 - particles which are emitted. If the end nucleus is $^{A}_{Z}X$, A and Z are given by :

Option 1:
A = 208 ; Z = 80

Option 2:
A = 200 ; Z = 81

Option 3:
A = 202 ; Z = 80

Option 4:
A = 208 ; Z = 82

Correct Answer:
A = 208 ; Z = 82

Solution:

α -decay -

$$^{A}_{Z}X \rightarrow ^{A-4}_{Z-2}Y + ^{4}_{2}He + Q$$

- wherein

$$Q\ value = (M_X - M_Y - M_{He})\,c^2$$

β plus decay -

$$^{A}_{Z}X \rightarrow ^{A}_{Z-1}Y + \beta^{+} + \nu + Q\ value$$

- wherein

$$\nu \rightarrow\ neutrino$$

$$Q\ value = [M_X - M_Y - 2M_e]\,c^2$$

Initially $^{232}_{90}Th$

Let initially $^{A}_{Z}X$

So let reaction

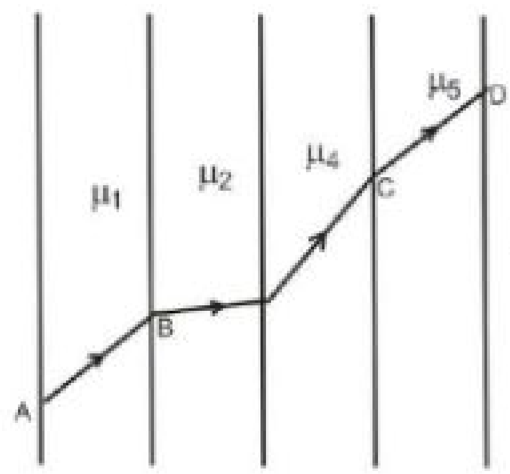
$^{232}_{90}Th \rightarrow ^{A}_{Z}X + 6^{4}_{2}He + 4\beta particle$

Balance $90 = Z + (6 \times 2) + 4 \times (-1) = 82$

Balance $232 = A + 6 \times 4 + 0 = 208$

So A = 208 and Z = 90

Q. 25



Arrengment of four prallel slab are s

diagram if the ray AB is parallel to CD then we must hav

Option 1:
$\mu_1 = \mu_2$

Option 2:
$\mu_2 = \mu_3$

Option 3:
$\mu_3 = \mu_4$

Option 4:
$\mu_4 = \mu_1$

Correct Answer:
$\mu_4 = \mu_1$

Solution:

As wev learn

Refraction through parallel slab -

$$s = t\left(1 - \frac{1}{\mu}\right)$$

- wherein

$S =$ shifting of object from slab

$T =$ thickness of slab

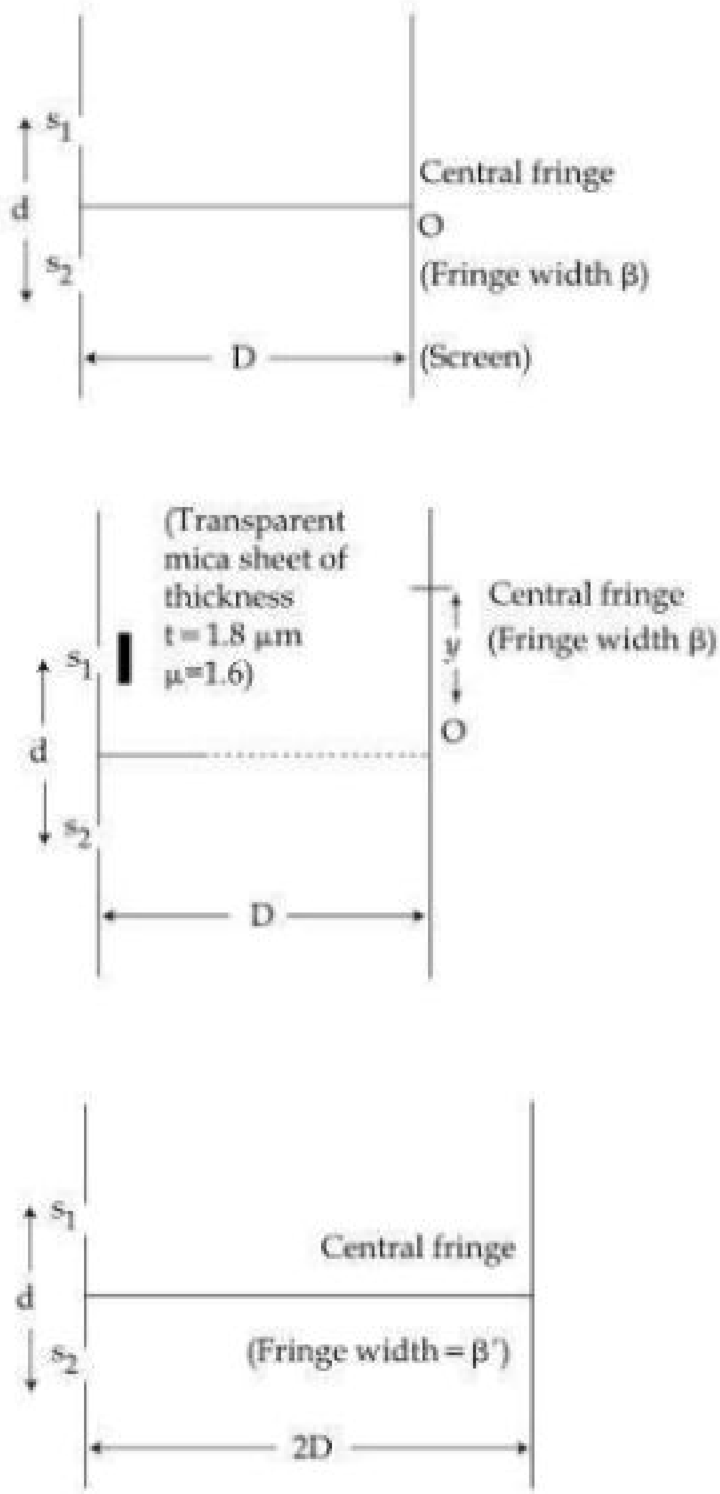
$\mu =$ Refractive Index of slab.

For AB to pralle to CD

$\mu_4 = \mu_1$

Q. 26 Using monochromatic light of wavelength λ, an experimer
slit experiment in three ways as shown.

If she observes that $y = \beta'$, the wavelength of light used is :



Option 1:
520 nm

Option 2:
540 nm

Option 3:
560 nm

Option 4:
580 nm

Correct Answer:
540 nm

Solution:

Given

$t = 1.8 \times 10^{-6} m$

$\mu = 1.6$

In young's double slit experiment, the fringe width $= \beta = \dfrac{D\lambda}{d}$

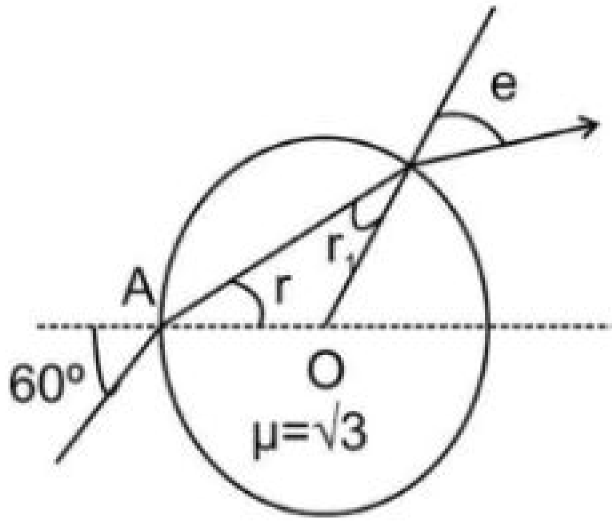
The fringe width of the 3^{rd} figure $= \beta' = \frac{2D\lambda}{d}$ [as the distance between screen and slits is $2D$]
In the 2^{nd} figure as there is a material between slit and screen there will be shift of central fringe
The shift $= y = \frac{D(\mu-1)t}{d}$
From the question $y = \beta'$
$\frac{D(\mu-1)t}{d} = \frac{2D\lambda}{d}$
$(\mu - 1)t = 2\lambda$
$\lambda = (\mu - 1)\frac{t}{2}$

Now $\Rightarrow$ $(1.6 - 1) \times 1.8 \times 10^{-6} = 2\lambda$

$\lambda = \dfrac{1.8 \times 10^{-6} \times 0.6}{2} = 540\ nm$

Correct option is 2.

Q. 27 A light ray is incident on a glass sphere of refractive index $\mu=\sqrt{3}$ at an angle of incidence 600 as shown the total deviation after two refraction is



Option 1:
300

Option 2:
450

Option 3:
750

Option 4:
600

Correct Answer:
600

Solution:

As we learn

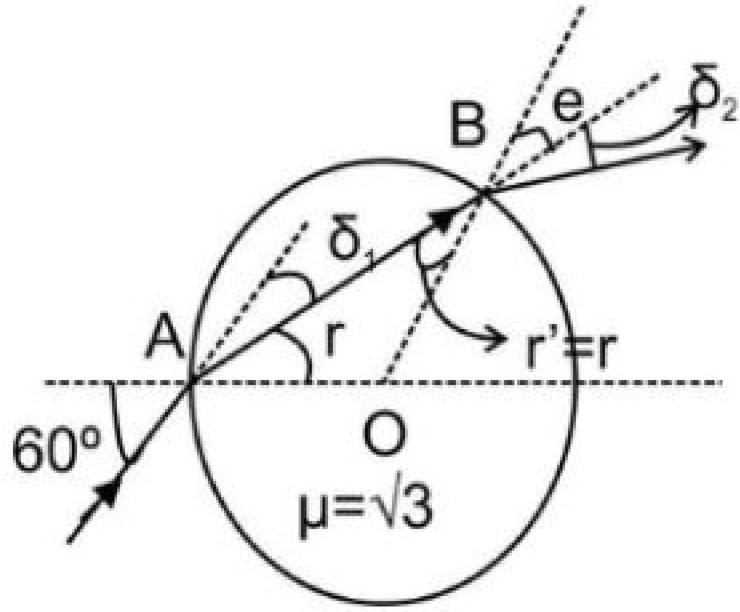
deviation due to refraction -

$\delta = i - r$

- wherein

$i =$ angle of incidence.

$R =$ angle of refraction.



At point A:

$$1.\sin 60^0 = \sqrt{3}\sin r$$

$$\Rightarrow r = 30^0$$

from symmetry

$$r' = r = 30^0$$

Apply snell's law at B

$$1.\sin e = \sqrt{3}\sin r' = \frac{\sqrt{3}}{2}$$

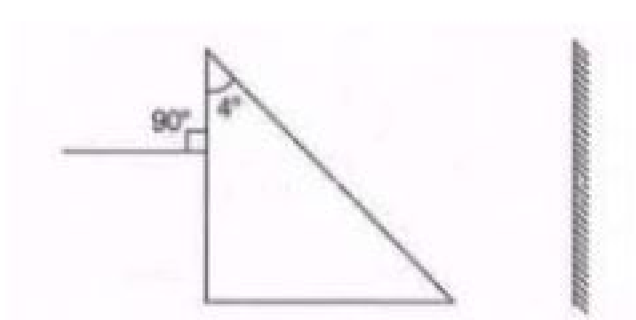
$$\Rightarrow e = 60^0$$

$$\delta_1 = 60^0 - 30^0 = 30^0$$

$$\delta_2 = e - r^1 = 60^0 - 30^0 = 30^0$$

$\therefore$ total deviation =600

Q. 28 A right angled prism of apex angle 40 and r. i. 1.5 is loc
as shown in g. horizontal ray of light is falling on the p
produced in the light ray at it emerges second time fror



Option 1:
80 cw

Option 2:
$6^0 cw$

Option 3:
$180^0 cw$

Option 4:
$178^0 cw$

Correct Answer:
$176^0 cw$

Solution:
As we learn

Deviation from thin prism -

$\delta = (\mu - 1)\, A$

- wherein

Applicable when A is very small

(i.e. thin prism)

Deviation produced by prism is

$\delta_1 = (\mu - 1)A = 2cw$

Angle of incidence of the mirror is δ_1, so deviation produced by mirror is

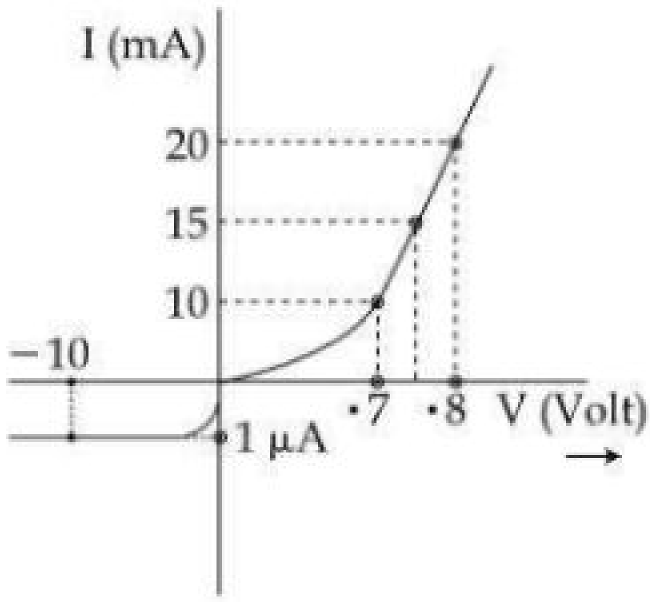
$\delta_2 = \pi - 2\delta_1 = 176^0 cw$

deviation produced by the prism for second refraction is

$\delta_3 = 2^0 Acw$

Net deviation is 1760 cw

Q. 29 The V-I characteristic of a diode is shown in the gure. resistance is :



Option 1:
10

Option 2:
10^{-6}

Option 3:
106

Option 4:
100

Correct Answer:
10^{-6}

Solution:

-

Forward Resistance

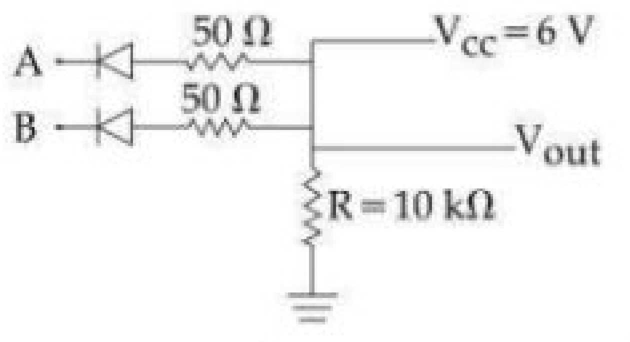
$$R_F = \frac{\Delta V}{\Delta i} = \frac{0.1}{10 \times 10^{-3}}\Omega$$

Reverse bias Resistance $= \frac{\Delta V}{\Delta i} = \frac{10}{10^{-6}} = 10^7\Omega$

Ratio of forward to reverse bias resistance $= \frac{10}{10^7} = 10^{-6}$

Correct option is 2.

Q. 30



Given : A and B are input terminals.

Logic 1 = > 5 V

Logic 0 = < 1 V

Which logic gate operation, the following circuit does ?

Option 1:
AND Gate

Option 2:
OR Gate

Option 3:
XOR Gate

Option 4:
NOR Gate

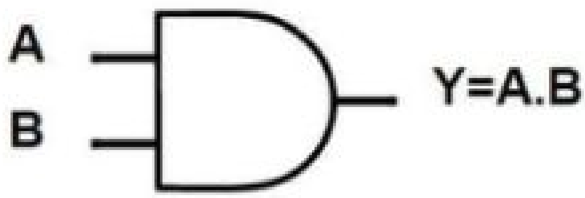
Correct Answer:
AND Gate

Solution:

As we have learned

AND Gate -

$Y = A \cdot B$



- wherein

A and B are input

Y is out put

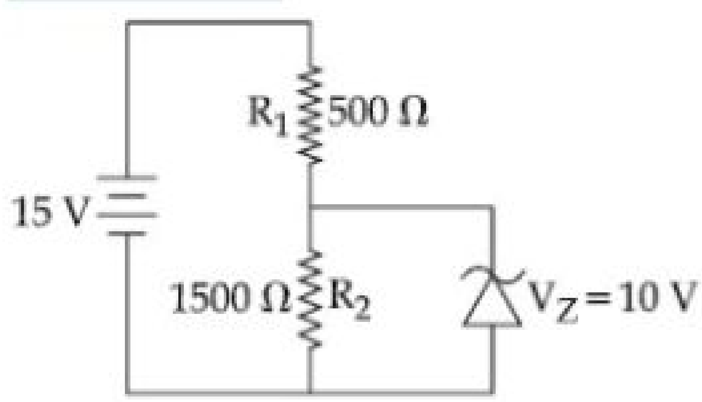
When both inputs > 5 V then $V_{out} > 5V$

When one of the inputs is > 5 V and other < 1 V we get $V_{out} < 1V$

When both input are < 1 V Then $V_{out} < 1V$

Hence	A	B	output
	1	1	1
	1	0	0
	0	1	0
	0	0	0

Q. 31 In the given circuit, the current (in mA) through zener



Correct Answer:
3.3

Solution:
As we have learned

Zener diode -

It can operate continuously without being damaged in the reg

- wherein

1) It acts as voltage regulator

2) In forward biasing it act as ordinary diode .

potential di rence across $R_2 = 10V$

potential di rence across $R_1 = 5V$

current through $R_1 = 5/500 = 0.01A$

current through $R_2 = 10/1500 = 0.01A = 1/150$

current through zener diode $= 1/100 - 1/150 = \frac{3-2}{300} = 1/300 = 3.3mA$

Q. 32 In a Young's double slit experiment with light of wavele λ distance of screen is D such that D λ β > > d > >. If the Frin point of maximum intensity to the point where intensity on either side is :

Option 1:
$\frac{\beta}{2}$

Option 2:
$\frac{\beta}{4}$

Option 3:
$\frac{\beta}{3}$

Option 4:
$\frac{\beta}{6}$

Correct Answer:
$\frac{\beta}{4}$

Solution:

As we learnt in

Malus Law -

$I = I_0 \cdot \cos^2\theta$

$\theta =$ angle made by E vector with transmission axis.

- wherein

$i =$ Intensity of transmitted light after polarisation .

$I_0 =$ Intensity of incident light.

Fringe Width -

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

- wherein

$\beta = y_{n+1} - y_n$

$y_{n+1} =$ Distance $(n+1)^{th}$

Maxima $= (n+1)\frac{\lambda D}{d}$

$y_n =$ Distance of n^{th}

maxima $= \frac{n\lambda D}{d}$

$$2I_0 = 4I_0 cos^2\left(\frac{\Delta\phi}{2}\right)$$

Here $\Delta\phi = \frac{\pi}{2}$

$\Delta\phi = \frac{2\pi}{\lambda}\Delta x$ so $\Delta x = \frac{\lambda}{4}$

$$\frac{dy}{\Delta}=\frac{\lambda}{4} \quad \text{(i)}$$

$$\frac{\lambda\Delta}{d}=\beta \quad \text{(ii)}$$

Thefore, from equation (i) and (ii)

$$y=\frac{\beta}{4}$$

Correct option is 2.

Q. 33 In young's double slit experiment, 16 fringes are observ screen when light of wavelength 700 nm is used. If the nm, the number of fringes observed in the same segmen

Option 1:
30

Option 2:
28

Option 3:
18

Option 4:
24

Correct Answer:
28

Solution:

$$y=\frac{D\lambda}{d}$$

$$\text{or } n_1\frac{D\lambda_1}{d}=n_2\frac{D\lambda_2}{d}$$

$$n_1\lambda_1=n_2\lambda_2$$

$$\frac{n_1}{n_2}=\frac{\lambda_2}{\lambda_1}$$

$$n_2=n_1\cdot\frac{\lambda_1}{\lambda_2}\Rightarrow 16\times\frac{700}{400}=28$$

Q.34 In a Young's double slit experiment, the path di erence between two interfering waves is $\frac{1}{8}$ th of the wavelength. The point to that at the centre of a bright fringe is close to

Option 1:
0.80

Option 2:
0.94

Option 3:
0.85

Option 4:
0.74

Correct Answer:
0.85

Solution:

Resultant Intensity of two wave -

$I = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\theta$

- wherein

$I_1 =$ Intencity of wave 1

$I_2 =$ Intencity of wave 2

$\theta =$ Phase di erence

$\Delta x = \frac{\lambda}{8}$

$\Delta\phi = \left(\frac{2\pi}{\lambda}\right)\frac{\lambda}{8} = \frac{\pi}{4}$

$I = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\theta$

Putting I_1 and $I_2 = I_o$

we get

$$\Rightarrow I = I_0 + I_0 + 2\sqrt{I_0 I_0}\cos\phi = 4I_0\cos^2\frac{\phi}{2}$$

At the centre $I_c = 4I_0$

and at that $I = I_0\cos^2(\frac{\pi}{8}) = I_c\cos^2(\frac{\pi}{8})$

$$\frac{I}{I_c} = \cos^2(\frac{\pi}{8})$$

$$\approx 0.85$$

Q. 35 Within a spherical charge distribution of charge density potential V0, V0 $+ \Delta V, V_0 + 2\Delta V, \ldots V_0 + N\Delta V$ $(\Delta V > 0)$, are drawn and have inc radii r0, r1, r2,..........rN, respectively. If the di erence for all values of V_0 and ΔV then

Option 1:
$\rho(r)\alpha r$

Option 2:
$\rho(r) = constant$

Option 3:
$\rho(r)\alpha\frac{1}{r}$

Option 4:
$\rho(r)\alpha\frac{1}{r^2}$

Correct Answer:
$\rho(r)\alpha\frac{1}{r}$

Solution:

As we learnt in

Relation between eld and potential -

$$E = \frac{-dv}{dr}$$

- wherein

$\frac{dv}{dr}$ - Potential gradient.

If P lies inside -

$E_{in} = \frac{1}{4\pi\epsilon_0}\frac{Qr}{R^3}$ $V_{in} = \frac{Q}{4\pi\epsilon_0}\frac{3R^2 - r^2}{2R^3}$

$E_{in} = \frac{\rho r}{3\epsilon_0}$ $V_{in} = \frac{\rho\,(3R^2 - r^2)}{6\epsilon_0}$

-

We know $E = \frac{-dv}{dr}$

Here ΔV and Δr are same for any pair of surfaces.

E= constant

Now, electric eld inside the spherical charge distribution

$E = \frac{\rho}{3\epsilon_0} r$

E would be constant if $\rho r = constant$

$\rho(r) \propto \frac{1}{r}$

Q. 36 A parallel plate capacitor is made of two plates of leng
distance d. A dielectric slab (dielectric constant K) that
near the edge of the plates. It is pulled into the capacit $F = -\frac{\partial U}{\partial x}$ where U is
the energy of the capacitor when dielectric is inside the
gure). If the charge on the capacitor is Q then the forc
edge is :

Option 1:
$\frac{Q^2 d}{2wl^2\epsilon_0}K$

Option 2:
$\frac{Q^2 w}{2dl^2\epsilon_0}(K-1)$

Option 3:
$\frac{Q^2 d}{2wl^2\epsilon_0}(K-1)$

Option 4:
$\frac{Q^2 w}{2dl^2\epsilon_0}K$

Correct Answer:
$\frac{Q^2 d}{2wl^2\epsilon_0}(K-1)$

Solution:

$$C = C_1 + C_2 = \frac{K(xw)\varepsilon_0}{d} + \frac{(l-x)w\varepsilon_0}{d}$$

$$C = \frac{w\varepsilon_0}{d} \times (Kx + (l-x))$$

$$U = \frac{1}{2} \times \frac{Q^2}{C} = \frac{Q^2 d}{2w\varepsilon_0(\varepsilon + (k-1)x)}$$

$$\frac{\partial U}{\partial x} = -\frac{dQ^2(K-1)}{2w\varepsilon_0(l + (k-1)x)^2}$$

$$F = -\frac{\partial U}{\partial x} = \frac{Q^2 d(K-1)}{2wl^2\varepsilon_0} \qquad at \quad x = 0$$

Q. 37 Figure shows a solid hemisphere with a charge of 5 nC d volume. The hemisphere lies on a plane and point P is lo line from the centre of curvature at distance 15 cm. The due to the hemisphere, is :

Correct Answer: 300

Solution:

Outside the sphere (P lies outside the sphere) -

$$E_{out} = \frac{1}{4\pi\epsilon_0}\frac{Q}{r^2} = \frac{\sigma R^2}{\epsilon_0 r^2}$$

$$V_{out} = \frac{1}{4\pi\epsilon_0}\frac{Q}{r} = \frac{\sigma R^2}{\epsilon_0 r}$$

- wherein

σ - surface charge density.

By argument of symmetry, it will be half of the potential pro

Q Charge on hemisphere = Q,

so charge on sphere = 2Q

$$\Rightarrow \frac{1}{2}.\frac{K(2Q)}{R}=\frac{KQ}{R}$$

$$V=\frac{KQ}{R}=\frac{9\times 10^{9}\times 5\times 10^{-9}}{15\times 10^{-2}}=300V$$

Q. 38 In the Bohr's model of hydrogen - like atom the force be is modi ed as,

$$F=\frac{e^2}{4\pi\epsilon_0}\left(\frac{1}{r^2}+\frac{\beta}{r^3}\right)$$

Where β is a constant . For the atom, the radius of the nth radius

$$\left(a_0=\frac{\epsilon_0 h^2}{m\pi e^2}\right)$$

Option 1:
$r_n=a_0\ n-\beta$

Option 2:
$r_n=a_0\ n^2+\beta$

Option 3:
$r_n=a_0\ n^2-\beta$

Option 4:
$r_n=a_0\ n+\beta$

Correct Answer:
$r_n=a_0\ n^2-\beta$

Solution:

$$F=\frac{mv^2}{r}=\frac{e^2}{4\pi\varepsilon_0}\left(\frac{1}{r^3}+\frac{\beta}{r^3}\right)$$

From Bohr's postulate

$\therefore v = \frac{nh}{2\pi mr}$

comparing both we get

$$\frac{n^2h^2}{4\pi^2m^2r^2} = \frac{e^2}{4\pi\varepsilon_0 m}\left(\frac{1}{r} + \frac{\beta}{r^2}\right)$$

So,

$$r_n = a_0 n^2 - \beta$$

Q. 39 Muon (μ^-) is a negatively charged ($|q| = |e|$) particle with a mass $m_\mu = 200\, m_e$, where m_e is the mass of the electron and e is the electronic charge. If μ^- is bound to a proton to form a hydrogen like atom, identify the correct stateme

(A) Radius of the muonic orbit is 200 times smaller than

(B) The speed of the μ^- in the n^{th} orbit is $\frac{1}{200}$ times that of the electron in th

(C) The ionization energy of muonic atom is 200 times m

(D) The momentum of the muon in the n^{th} orbit is 200 times more than that

Option 1:
(A), (B), (D)

Option 2:
(A), (C), (D)

Option 3:
(B), (D)

Option 4:
(C), (D)

Correct Answer:
(A), (C), (D)

Solution:

As we learnt

Radius of nth orbital -

$$r_n = \frac{\epsilon_0 n^2 h^2}{\pi m Z e^2}$$

- wherein

$r_n \alpha \frac{n^2}{Z}$

$\frac{\epsilon_0 h^2}{\pi m e^2} = 0.529 A^\circ$

and

Energy of electron in nth orbit -

$E = -\left(\frac{me^4}{8\epsilon_0^2 h^2}\right)\frac{z^2}{n^2}$

- wherein

$E \alpha \frac{z^2}{n^2}$

$\frac{me^4}{8\epsilon_0^2 h^2} = 13.6 ev$

$R = \frac{\epsilon_0 n^2 h^2}{\Pi m z e^2}., \; E = \frac{m z^2 e^4}{8\epsilon_0^2 n^2 h^2}$

$m' = 200 m_e$

$R' = \frac{R}{200}; \; E' = 200E$

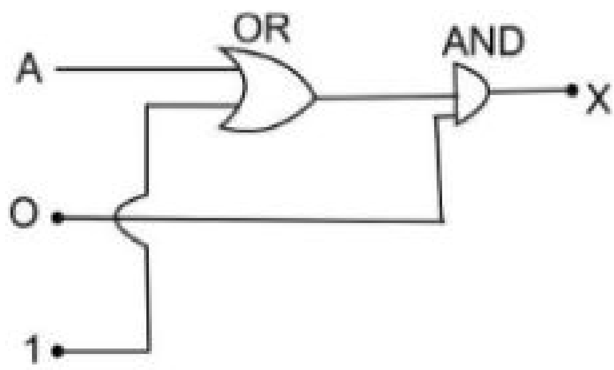
Velocity of electron in nth orbital

$v = \left(\frac{e^2}{2\epsilon_0 h}\right)\frac{z}{n}$

$p' = 200p$

hence, option (2) is correct

Q. 40 The output, in the folowing gate logic, would be:



Option 1:
0

Option 2:
1

Option 3:
A

Option 4:
1 + A

Correct Answer:
0

Solution:

As we have learned

Some Important relation -

$$A + A = A$$

$$A \cdot A = A$$

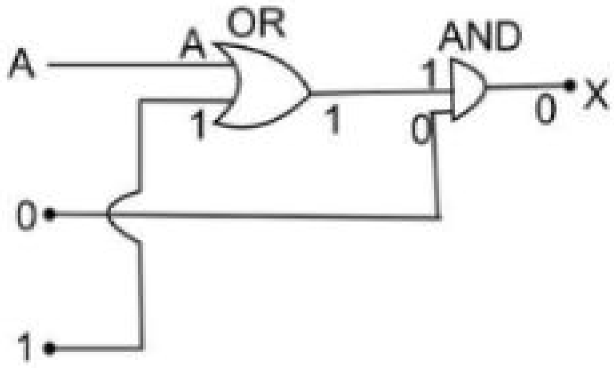
$$A + 1 = 1$$

$$A \cdot 1 = 1$$

$$A \cdot 0 = 0$$

$$A + 0 = A$$

-



We know 1+A=1 always, hence the output of OR gate would be

1	A	OR
1	0 1	1
1		1

Similarly $a \cdot 0 \neq 0$

We know that output of AND gate is zero, if atleast one input

A	0	AND
1	0	0
0	0	0

Hence X=0

Chemistry

Q.1 Resistanceof 0.2 M solution of the electrolyte is 50 Ω. The specific conductance of the solution is 1.4 S m-1. The resistance of 0.5 M solution of ... Ω. The molar conductivity of 0.5 M solution of the electrolyte i

Option 1:
5×10^{-4}

Option 2:
5×10^{-3}

Option 3:
5 x 103

Option 4:
5 x 102

Correct Answer:
5×10^{-4}

Solution:

Speci c conductance,

$$\sigma = 1.4 Sm^{-1} = 1.4 \times 10^{-2}\, 5cm^{-1}$$

Resistivity,

$$\rho = \frac{1}{\kappa} = \frac{1}{1.4 \times 10^{-2}}\, \Omega cm$$

Resistance, R = $\frac{\rho l}{A}$

Now, for a 0.5 M solution, R = 280 Ω

$$\kappa = \frac{1}{\rho} = \frac{1}{R} \times \frac{l}{A} = \frac{1}{280} \times 50 \times 1.4 \times 10^{-2}$$

$$= 2.5 \times 10^{-3} Scm^{-1}$$

$\therefore$ molar conductivity,

$$\mu = \frac{\kappa \times 1000}{c} = \frac{2.5 \times 10^{-3} \times 1000}{0.5}$$

$= 5\ \mathrm{Scm^2mol^{-1}}$

$$= 5 \times 10^{-4} \mathrm{Sm^2mol^{-1}}$$

Therefore, the correct option is (1).

Q.2 The standard reduction potentials for Zn^{2+}/Zn, Ni^{2+}/Ni and Fe^{2+}/Fe are −0.76, −0.23 and −0.44 V respectively.

The reaction $X + Y^{2+} \rightarrow X^{2+} + Y$ will be spontaneous when :

Option 1:
X = Ni, Y = Fe

Option 2:
X = Ni, Y = Zn

Option 3:
X = Fe, Y = Zn

Option 4:
X = Zn, Y = Ni

Correct Answer:
X = Zn, Y = Ni

Solution:

For a spontaneous reaction, Eo must be positive.

So, Eo = Eo reduced constituent - Eo oxidized constituent

Eo = (-0.23) - (-0.76)

[We get this by maximizing EoR and minimizing EoO]

Alternatively, we can also solve this qualitatively. Elements w agents and therefore, can be easily oxidized. Also, elements w oxidizing agents and can be reduced easily. Keeping the abov
$X = Zn$ and $Y = Ni$ and the reaction is:

$Zn + Ni^{2+} \rightarrow Zn^{2+} + Ni$

Therefore option (4) is correct

Q.3 In a 0.2 molal aqueous solution of a weak acid HX, the d for water as 1.85 K molal-1 , the freezing point of the so

Option 1:
$-0.480°C$

Option 2:
$-0.360°C$

Option 3:
$-0.260°C$

Option 4:
$+0.480°C$

Correct Answer:
$-0.480°C$

Solution:
Case of dissociation

$HX \rightleftharpoons H^+ + X^-$

van't Hoff factor (i) $= 1 + (n-1)\alpha = 1 + (2-1)\,0.3 = 1.3$

$\Delta T_f = iK_f \times m$

$\Delta T_f = 1.3 \times 1.85 \times 0.2 = 0.4810$

Freezing point of solution = -0.4810 oc.

Correct option is (1)

Q.4 Aluminium oxide may be electrolysed at 1000°C to furnis
amu,1 Faraday= 96,500 Coulombs) The cathode reaction

$$Al^{3+} + 3e^{-} \rightarrow Al^{0}$$

To prepare 5.12 kg of aluminium metal by this method w

Option 1:
5.49×10^{7}C of electricity

Option 2:
1.83×10^{7}C of electricity

Option 3:
5.49×10^{4}C of electricity

Option 4:
5.49×10^{1} C of electricity

Correct Answer:
5.49×10^{7}C of electricity

Solution:

$$\text{Moles of Al} = \frac{5.12 \times 1000}{27}$$

$$\approx 190$$

$$\therefore \text{Moles of } e^{-} = 3 \times 190 \therefore \text{Total charge} = 3 \times 190 \times 96500$$

$$\simeq 5.49 \times 10^{7}\text{C}$$

Therefore, the correct option is (1).

Q.5 Two liquids X and Y form an ideal solution. At 300 K, va
containing 1 mol of X and 3 mol of Y is 550 mm Hg. At th
further added to this solution, vapour pressure of the
Vapour pressure (in mm Hg) of X and Y in their pure sta

Option 1:
200 and 300

Option 2:
300 and 400

Option 3:

400 and 600

Option 4:

500 and 600

Correct Answer:

400 and 600

Solution:

$P = P_A^0 \chi_A + P_B^0 \chi_B$

Given that 1 mole of X and 3 moles of Y are present

$\therefore \chi_A = \frac{1}{4}, \ \chi_B = \frac{3}{4}$

$550 = p_A^0 \times \frac{1}{4} + p_B^0 \times \frac{3}{4}$ (1)

After adding 1 mole y the vapour pressure is 560

$560 = p_A^0 \times \frac{1}{5} + p_B^0 \times \frac{4}{5}$ (2)

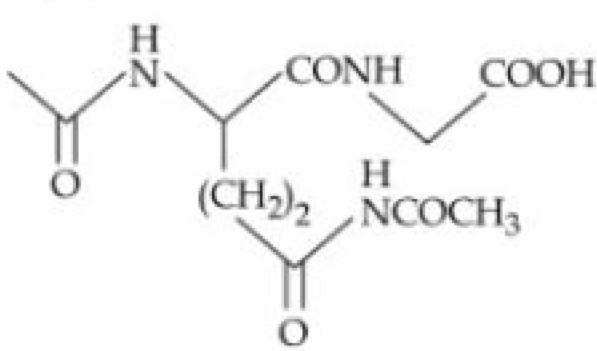
By solving equation 1 & 2

$p_A^0 = 400, \ p_B^0 = 600$

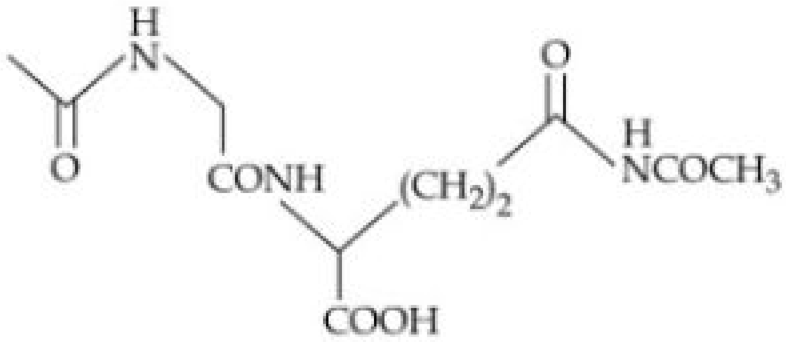
Therefore option(3) is correct.

Q.6 The dipeptide, Gln-Gly, on treatment with CH_3COCl follo

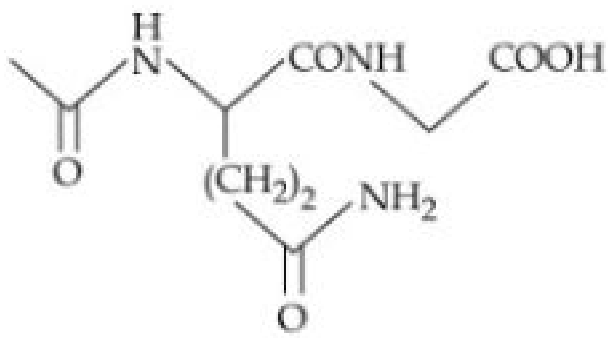
Option 1:



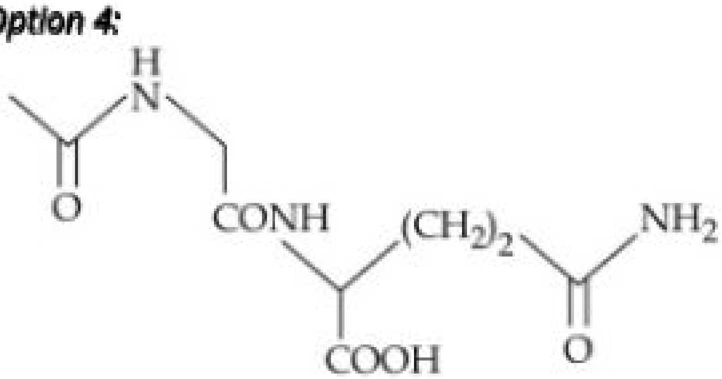
Option 2:



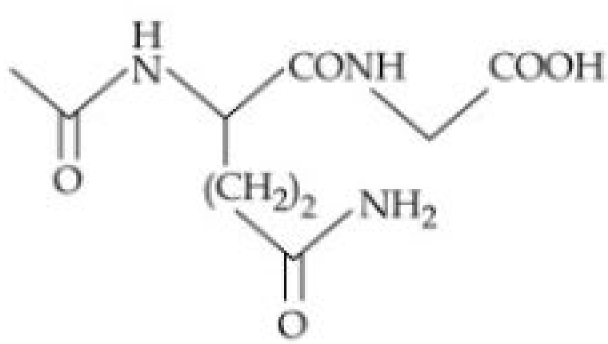
Option 3:



Option 4:



Correct Answer:



Solution:

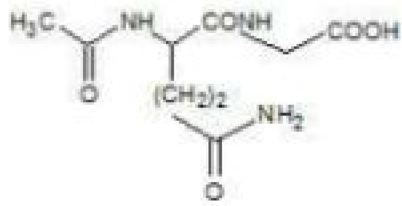
As we learnt in

Polypeptide -

Many amino acid hooked together

-

Gly-Gly on treatment with CH3COCl followed by hydrolysis gi



Q.7 Which one of the following statements is FALSE?

Option 1:
The correct order of osmotic pressure for 0.01 M aqueous sol
CH3COOH > sucrose.

Option 2:
The osmotic pressure (π) of a solution is given by the equation $\pi = MRT$ where M is the mola
of the solution.

Option 3:
Raoult's law states that the vapour pressure of a component
mole fraction.

Option 4:
Two sucrose solutions of same molality prepared in di erent
point depression.

Correct Answer:
Two sucrose solutions of same molality prepared in di erent
point depression.

Solution:
As we have learnt
Freezing -
Freezing occurs when liquid solvent is in equilibrium with solid solvent. As non volatile solute decreases, the vapour pressure freezing point decreases.

The extent of depression in freezing point varies with the nun
only and it is a characteristics feature of the nature of solver
extent of depression may vary even if number of solute partic

Therefore, option(4) is correct

Q.8 The rise in the boiling point of a solution containing 1.8
in 0.10C. The molal elevation constant of the liquid is:

Option 1:
$0.01K/m$

Option 2:
$0.1K/m$

Option 3:
$1K/m$

Option 4:
$10K/m$

Correct Answer:
$1K/m$

Solution:
$\Delta T_b = K_b\, m$

$$K_b = \frac{\Delta T_b}{m} = \frac{0.1 \times 100}{\frac{1.8}{180} \times 1000} = 1K/m$$

Therefore option (3) is correct

Q.9 For the rst-order reaction:
$2N_2O_5\,(g) \rightarrow 4NO_2\,(g) + O_2\,(g)$

(A) The concentration of the reactant decreases exponen

(B) The half-life of the reaction decreases with increasi

(C) The half-life of the reaction depends on the initial c

(D) The reaction proceeds to 99.6% completion in eight

The correct statements are -

Option 1:
Only A and B

Option 2:
Only B and C

Option 3:
A, B, and D

Option 4:
A, B, C, and D

Correct Answer:
Only A and B

Solution:

A) The concentration of reactant which is following rst-order
and becomes zero at in nity.

$A_t = A_o e^{-kt}$

B) The half-life of the reaction decreases with increasing tem

As the temperature increases, the rate constant increases and
inversely dependent on the rate constant.

$t_{1/2} = \frac{\ln 2}{k}$

$t_{1/2} \propto \frac{1}{k}$

K increase on increasing T.

C) The half-life of the reaction does not depend on the initial concentration of the r

$t_{1/2} = \frac{\ln 2}{k}$

D) The reaction proceeds to 99.6% completion in eight half-lif

After eight half-lives.

$A = \frac{A_0}{2^8}$

$\% \text{ completion } = \frac{A_o - \frac{A_o}{2^8}}{A_o} \times 100 = 99.6\%$

So, A, B, and D are correct.

Option 3 is correct.

Q.10 What is the value of equilibirum constant for a reaction $\Delta G^0 = -15.38\,kJ$?

Option 1:
$10^{2.695}$

Option 2:
$e^{2.695}$

Option 3:
$e^{1.738}$

Option 4:
$10^{1.738}$

Correct Answer:
$10^{2.695}$

Solution:

As we have learned

Standard Gibbs Energy -

$\Delta_r G^0 = -RT\ ln\ k$

- wherein

K= equilibrium constant of the reaction

$\Delta G^0 = -RTlnK$

$-15.38 = -8.314 * 298 * 2.303 logK$

$K = 10^{2.695}$

Q.11 Match the following

1. Glyptal 2. Polyvinyl Acetate 3. Polyvinyl Chloride 4. Buna-S	a. Homopolymer b. Copolymer	p. tyres, rubber q. paints and lacquers r. latex paint s. water pipes, hoses

Option 1:
1-a,q, 2-b,r, 3-b,s, 4-a,q

Option 2:
1-b,q, 2-a,r, 3-s,a, 4-b,q

Option 3:
1-b,p, 2-a,s, 3-b,r, 4-a,q

Option 4:
1-a,p, 2-b,s, 3-a,r, 4-b,q

Correct Answer:
1-b,q, 2-a,r, 3-s,a, 4-b,q

Solution:

Glyptal is a copolymer used in tyres, rubber.

Polyvinyl Acetate is a copolymer used in tyres, rubber.

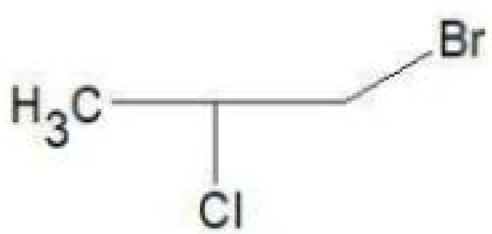
Polyvinyl Chloride is a homopolymer used in water pipes, hose

Buna-S is a copolymer used in paints and lacquers.

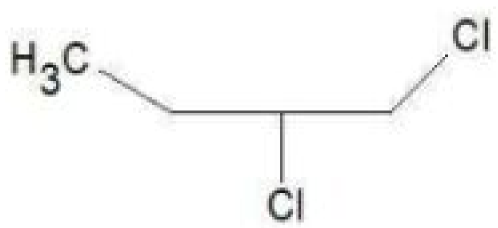
So, Option 2 is correct.

Q.12 Which ones are dihalogen derivatives of alkanes?

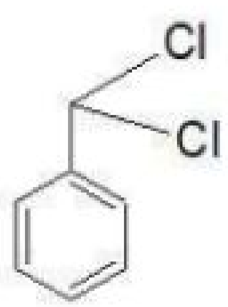
a)



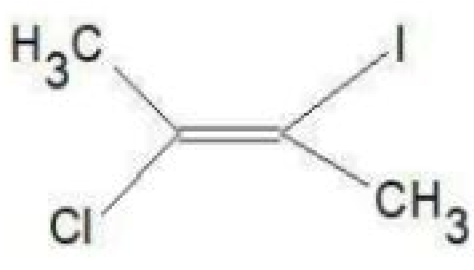
b)



c)



d)



Option 1:
a, b only

Option 2:
a, b and d only

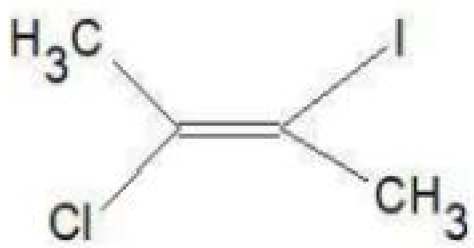
Option 3:
b only

Option 4:
a,band c only

Correct Answer:
a,band c only

Solution:
Dihalogen derivatives of hydrocarbons contain two halogen at

Here, in



it is Dihalogen derivatives of alkene not alkane.

In (c) Hydrogen is replaced from the alkane group, not from B
of alkene.

a,b and c are Dihalogen derivatives of alkene.

Therefore, option (4) is correct.

Q. 13 When PbS is oxidised by Cl_2 it forms

Option 1:
$PbSO_4$

Option 2:
SO_2

Option 3:
SO_3

Option 4:
S

Correct Answer:
$PbSO_4$

Solution:
Cl2 oxidises PbS to PbSO4

The reaction is given as

$$4Cl_2 + PbS + 4H_2O \rightarrow PbSO_4 + 8HCl$$

Hence the correct answer is Option (1)

Q. 14 The magnetic moment of an octahedral homoleptic Mn (I
ligand for this complex is :

Option 1:
CO

Option 2:
ethylenediamine

Option 3:
NCS-

Option 4:
CN-

Correct Answer:
NCS-

Solution:

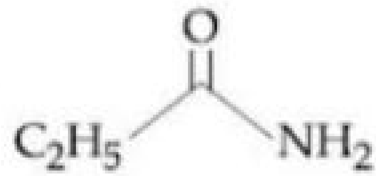
As we have learnt in magnetic moment,

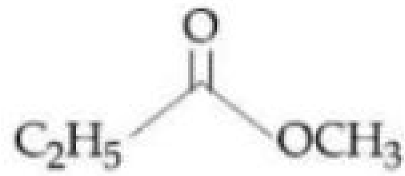
$\mu = 5.9BM$ implies that the number of unpaired electrons = 5 .

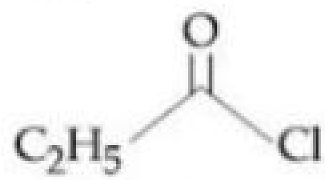
Now Mn^{2+} has d^5 configuration and presence of 5 unpaired electrons
eld ligands like NCS^-

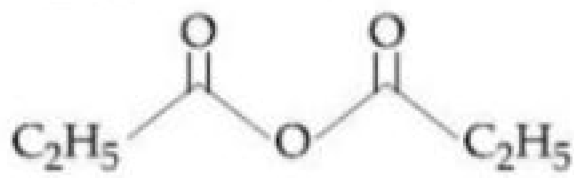
Therefore, option (3) is correct.

Q. 15 The increasing order of the reactivity $LiAlH_4$ of the following w

(A) 

(B) 

(C) 

(D) 

Option 1:
(B) < (A) < (D) < (C)

Option 2:
(B) < (A) < (C) < (D)

Option 3:
(A) < (B) < (C) < (D)

Option 4:
(A) < (B) < (D) < (C)

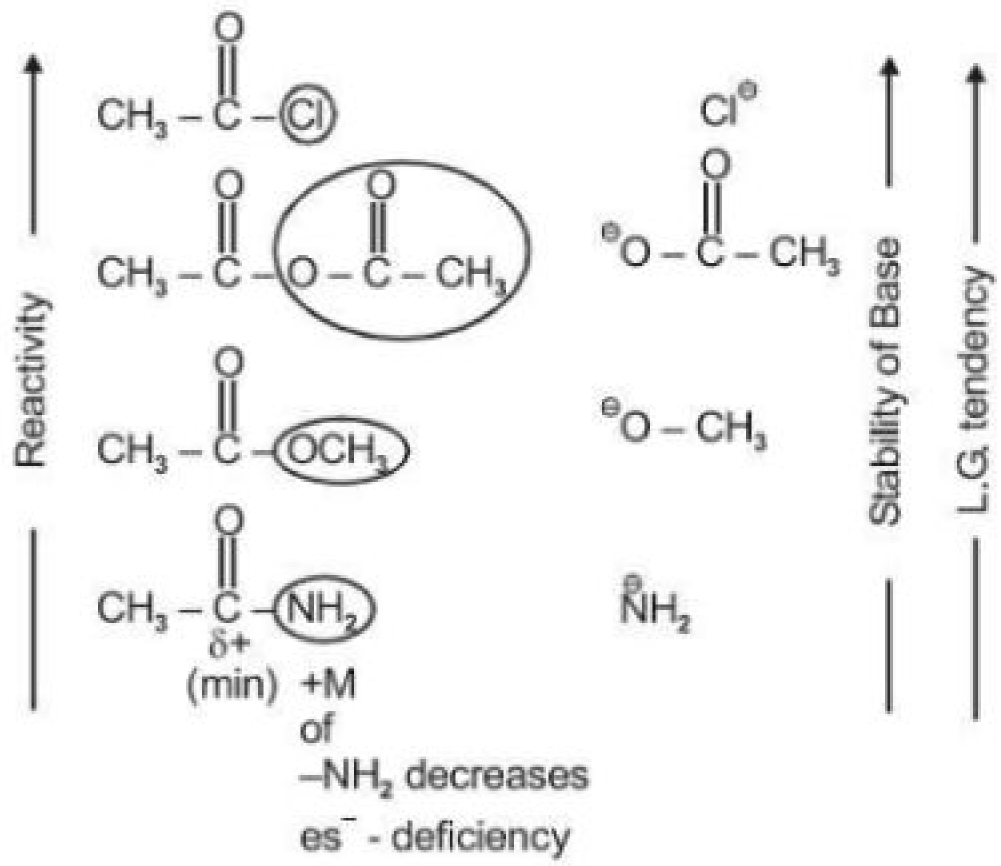
Correct Answer:
(A) < (B) < (D) < (C)

Solution:

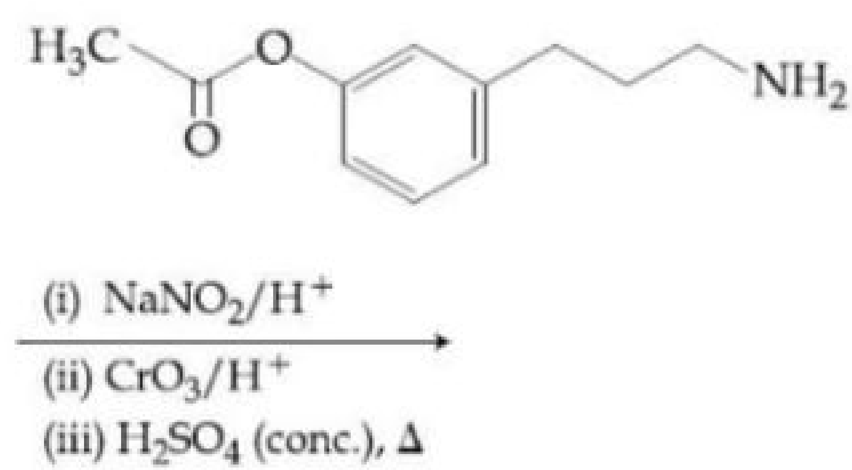
Reactivity of  group

∝ Electrophilicity of Carbonyl group

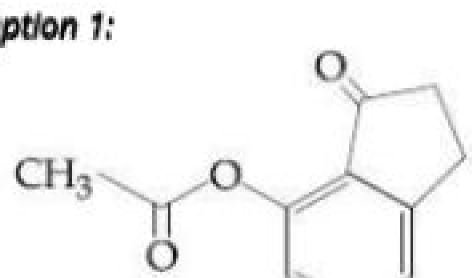
∝ Leaving group tendency.



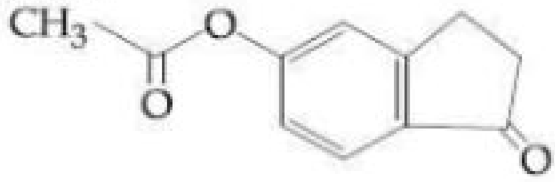
Q. 16 The major product of the following reaction is :



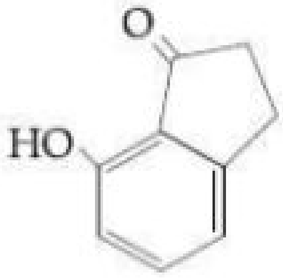
Option 1:



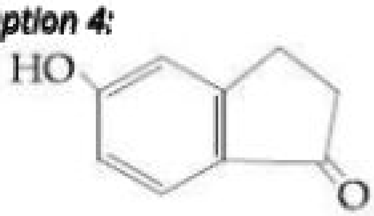
Option 2:



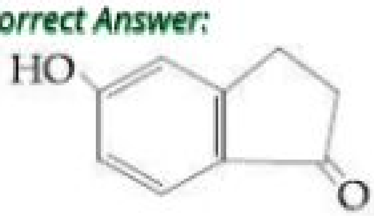
Option 3:



Option 4:

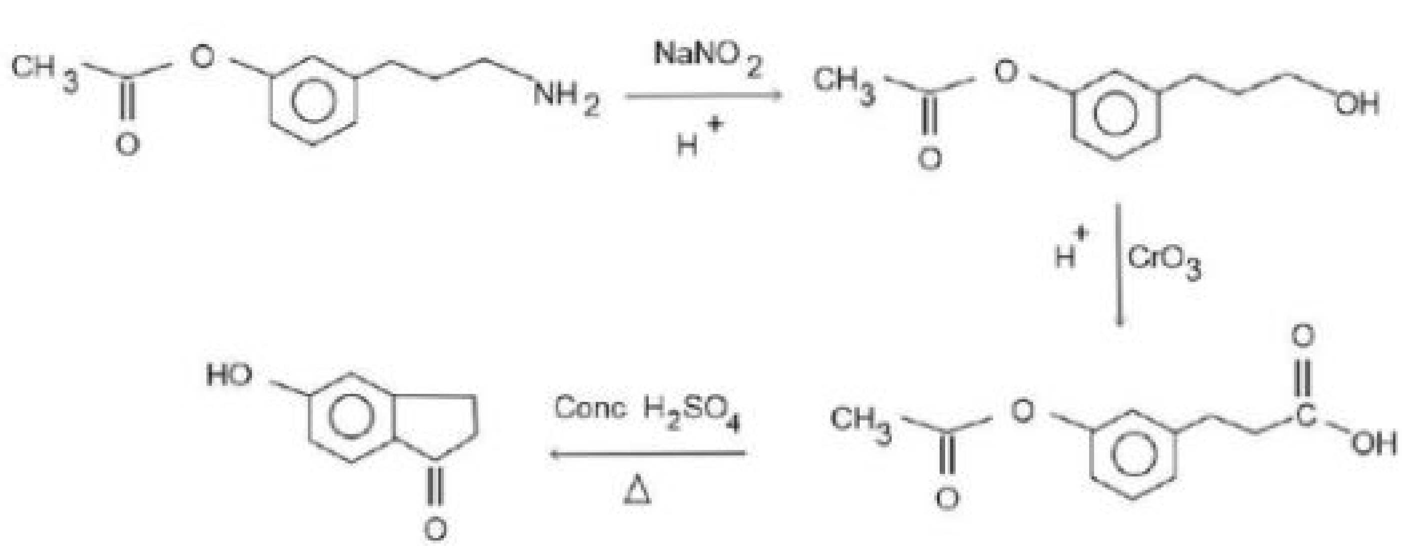


Correct Answer:



Solution:

As we have learned



Therefore option (4) is correct.

Q.17 For the $Zn(s)|Zn^{2+}(aq)||M^{x+}(aq)|M(s)$, di erent half cells and thei electrode potential are given below :

$M^{x+}(aq)/M(s)$	$Au^{3+}(aq)/Au(s)$	$Ag^{+}(aq)/Ag(s)$	$Fe^{3+}(aq)/Fe^{2+}(aq)$	$Fe^{2+}(aq)/Fe(s)$
$E^{\circ}_{M^{x+}/M}/(V)$	1.40	0.80	0.77	−0.44

If $E^0_{zn^{2+}/zn} = -0.76V$, which cathode will give E^0_{cell} a maximum value per electron transfered?

Option 1:
Au^{3+}/Au

Option 2:
Fe^{3+}/Fe^{2+}

Option 3:
Fe^{2+}/Fe

Option 4:
Ag^{+}/Ag

Correct Answer:
Au^{3+}/Au

Solution:
We know that

$$\Delta_r G^{\ominus} = \Delta_1 G^{\ominus} + \Delta_2 G^{\ominus}$$

And

$$\Delta_r G^{\ominus} = -nFE^{\ominus}_{(cell)}$$

from above

$$nE^{o}_{(cell)} = n_1 E^{o}_1 + n_2 E^{o}_2$$

For Ag^{+}/Ag

$$Zn(s) + 2Ag^{+} \rightarrow Zn^{2+} + 2Ag$$

Electron transfer :

n (reaction) = 2 , n1(Zn) = 2, n2(Ag) = 1

and

Given $E^o_{Zn^{2+}/Zn} = -0.76$

So, $E^o_{Zn/Zn^{2+}} = 0.76$

After putting the value:

$2 \times E^o_{(cell)} = 2 \times (0.76) + 1 \times 0.80$

$2 \times E^o_{(cell)} = 2.32$

$E^o_{(cell)} = 1.16$

After calculating the other 1.16 will be the maximum.

Therefore,option(4) is correct

Q. 18 The freezing point of a diluted milk sample is found to be -0.2^0C, while it should have been -0.5^0C for pure milk. How much water has been added ... diluted sample ?

Option 1:
2 cups of water to 3 cups of pure milk.

Option 2:
3 cups of water to 2 cups of pure milk.

Option 3:
1 cup of water to 3 cups of pure milk.

Option 4:
1 cup of water to 2 cups of pure milk.

Correct Answer:
3 cups of water to 2 cups of pure milk.

Solution:

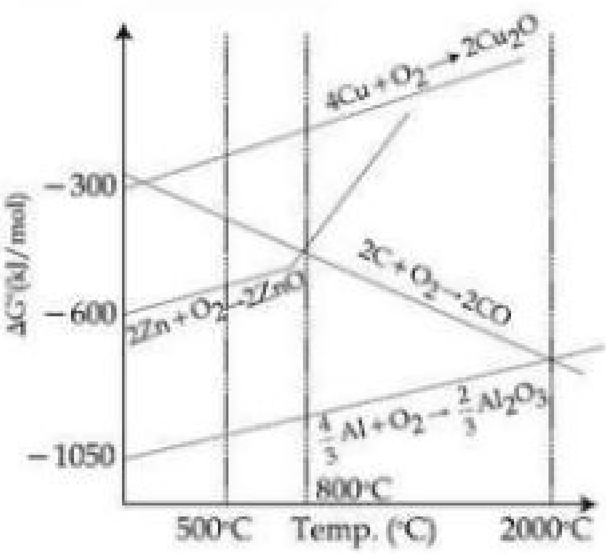
Freezing point of milk $= -0.5^0C \therefore \Delta T_f = 0.5^0C$

Freezing point of milk $= -0.2^0C \therefore \Delta T_f = 0.2^0C$

$$\frac{(\Delta T_f)\, i}{(\Delta T_f)\, ii} = \frac{0.5}{0.2} = \frac{K_f m}{K_f m} = \frac{x\,(mole) \times weight\,(2)}{weight_{(1)} \times x\,(mole)}$$

$$W_2 = \frac{5}{2} W_1$$

Q. 19 The correct statement regarding the given Ellingham di



Option 1:
At 500^0C , coke can be used for the extraction of Zn from ZnO

Option 2:
At 1400^0C , Al can be used for the extraction of Zn from ZnO

Option 3:
At 800^0C , Cu can be used for the extraction of Zn from ZnO.

Option 4:
Coke cannot be used for the extraction of Cu from Cu_2O.

Correct Answer:
At 1400^0C , Al can be used for the extraction of Zn from ZnO

Solution:

For extraction of less electropositive metals such as Pb, Zn, F
as C, H2, CO, Water gas, Na, K, Mg, Al may be used.

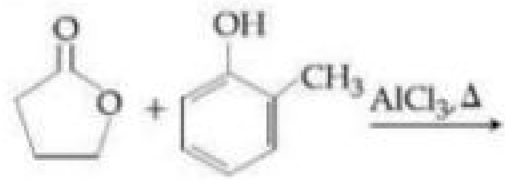
MxOy + yC → xM + yCO

From the diagram, Al can reduce ZnO to Zn

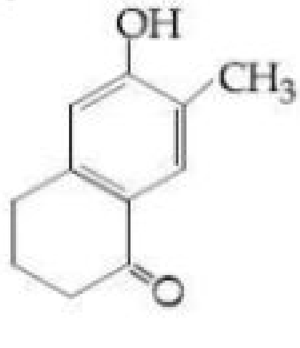
$3ZnO + 2Al \rightarrow Zn + Al_2O_3$

Therefore, option number (2) is correct.

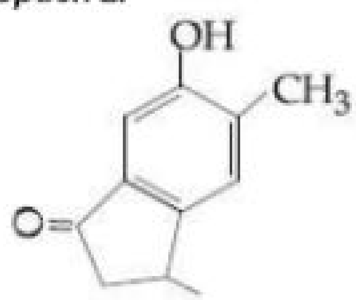
Q. 20 The major product of the following reaction is :



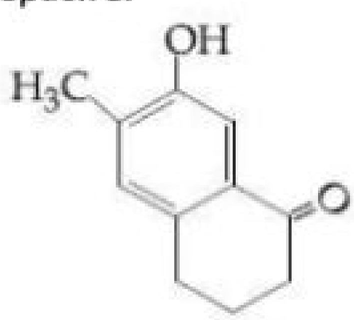
Option 1:



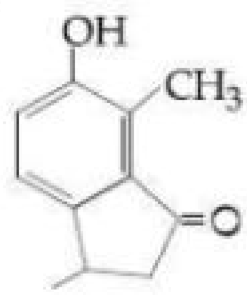
Option 2:



Option 3:



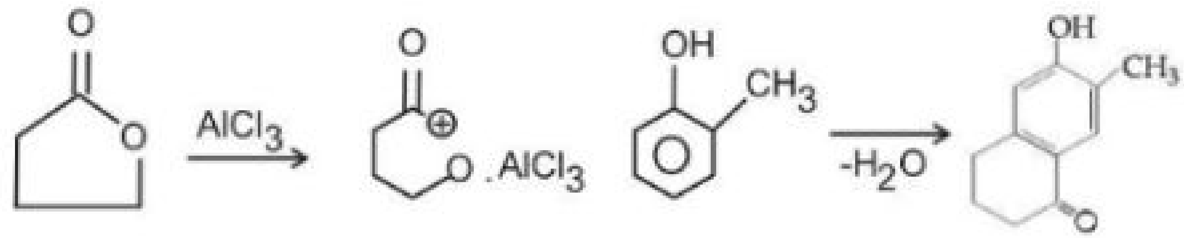
Option 4:



Correct Answer:

Solution:

The reaction will be



T h e r e foption (1) is correct.

Q. 21 The e ect of lanthanoid contraction in the lanthanoid se means?

Option 1:
Increase in both atomic and ionic radii.

Option 2:
Decrease in atomic radii and increase in ionic radii.

Option 3:
Decrease in both atomic and ionic radii.

Option 4:
Increase in atomic radii and decrease in ionic radii.

Correct Answer:
Decrease in both atomic and ionic radii.

Solution:

As we have learnt,

As a result of the Lanthanoid contraction, both the atomic ra lanthanoid series.

Therefore,option(3) is correct

Q. 22 A mixture of 100 m mol of $Ca(OH)_2$ and 2 g of sodium sulphate was diss and the volume was made up to 100 mL .The mass of calc concentration of OH^- in resulting solution , respectively are : ($Ca(OH)_2$ $.Na_2SO_4$ and $CaSO_4$ are 74, 143 and 136 g mol^{-1}, respectively ; K_{sp} of $Ca(OH)_2$ is 5.5×10^{-6})

Option 1:
$1.9\,g,\ 0.28\,mol\,L^{-1}$

Option 2:
$13.6g,\ 0.28\,molL^{-1}$

Option 3:
$1.9g,\ 0.14molL^{-1}$

Option 4:
$13.6g,\ 0.14molL^{-1}$

Correct Answer:
$1.9\,g,\ 0.28\,mol\,L^{-1}$

Solution:

Given,

Mol of Na2SO4 = 2/142 = 14 m mol

$$\underset{\text{mmol } 100}{Ca(OH)_2} + \underset{14}{Na_2SO_4} \longrightarrow \underset{14\text{ m/mol}}{CaSO_4} + \underset{28\text{ m/mol}}{2NaOH}$$

$$\text{Mass of } CaSO_4 = \frac{14 \times 136}{1000} = 1.9\text{ gm}$$

$$\text{Molarity of } OH^- = \frac{28}{100} = 0.28\text{ mol / L}$$

Q. 23 Liquids A and B form an ideal solution in the entire com
pressures of pure A and pure B are $7 \times 10^3 Pa$ and $12 \times 10^3 Pa$, respectively. The
composition of the vapor in equilibrium with a solution
this temperature is :

Option 1:
$x_A = 0.37;\ x_B = 0.63$

Option 2:
$x_A = 0.28;\ x_B = 0.72$

Option 3:
$x_A = 0.4;\ x_B = 0.6$

Option 4:
$x_A = 0.76;\ x_B = 0.24$

Correct Answer:
$x_A = 0.28;\ x_B = 0.72$

Solution:

We know that

$$y_a = \frac{P_A}{P_{total}} = \frac{P_A^0 \times X_A}{P_A^0 \times X_A + P_B^0 \times X_B}$$

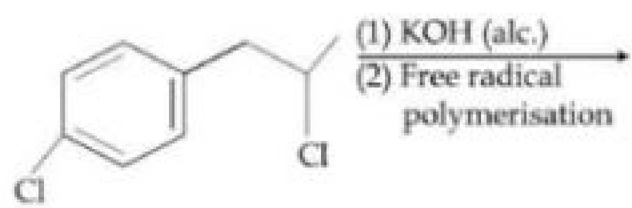
$$y_A = \frac{7 \times 10^3 \times 0.4}{7 \times 10^3 \times 0.4 + 12 \times 10^3 \times 0.6}$$

$$y_A = \frac{2.8}{10} = 0.28$$

$$y_B = 0.72$$

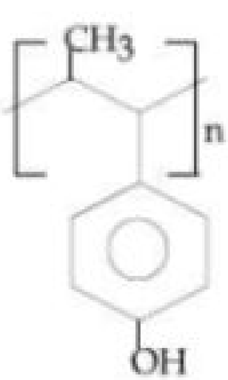
Therefore option(2) is correct

Q. 24 The major product of the following reaction is :

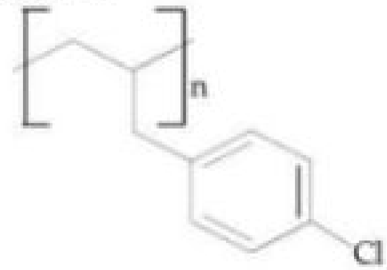


Option 1:

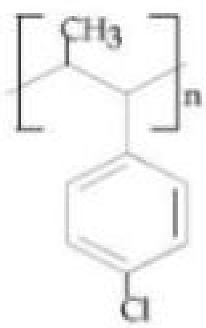
Option 2:



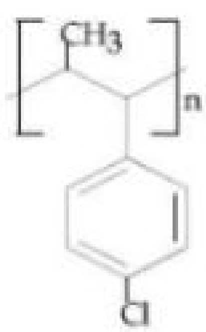
Option 3:



Option 4:



Correct Answer:



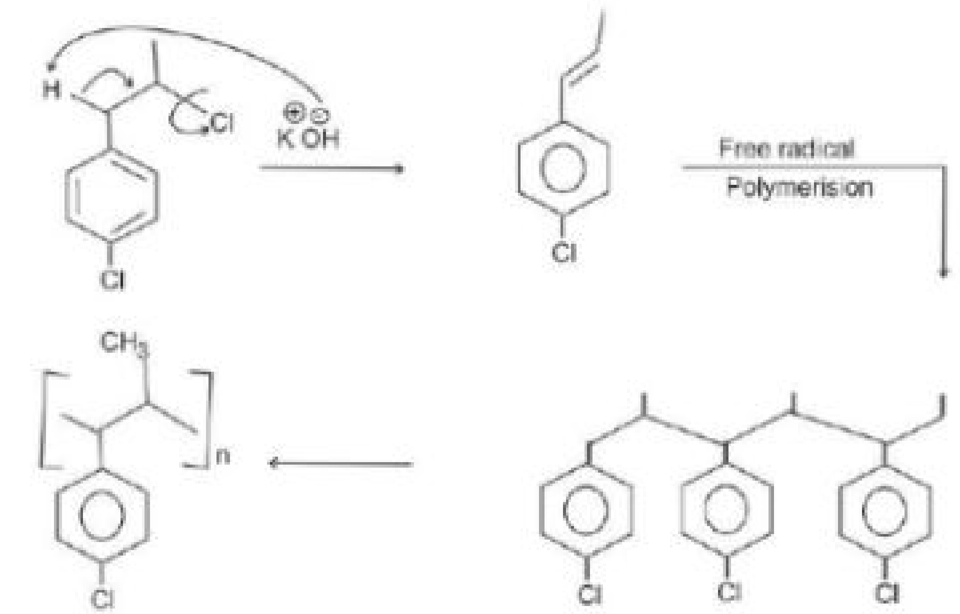
Solution:

Reaction of alkyl halide with KOH (alc) -

β- elimination reaction take place and produces alkenes.

- wherein

$$CH3CH2Br + KOH(alc.) \rightarrow H2C = CH2 + KBr + H2O$$



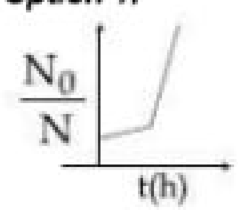
Q. 25 A bacterial infection in an $N'(t) = N_0 \exp(t)$ wound grows as

where the time t is in hours. A dose of antibiotic, taken
wound.

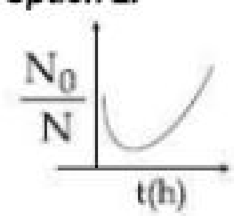
Once it reaches there, the bacterial population goes do $\frac{dN}{dt} = -5N^2$

What will be the plot of $\frac{N_0}{N}$ vs. t after 1 hour ?

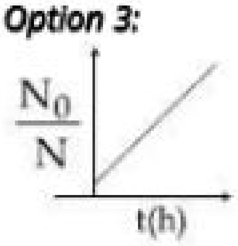
Option 1:



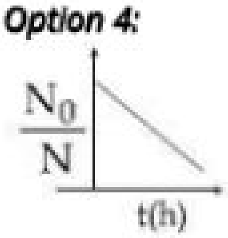
Option 2:



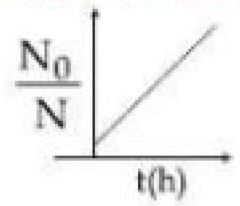
Option 3:



Option 4:



Correct Answer:



Solution:

From the $N(t) = N_o e^t$

After 1 hour, $\frac{dN}{dt} = -5N^2$ is given :

∴ at t = 1 hour, $N = eN_o$.

Now,

$$N^{-2}dN = -5dt$$

After 1 hour the graph will be from 1 hour to t hour and N' fro

$$\int_{eN_o}^{N} N^{-2}dN = -5\int_{1}^{t} dt$$

$$\frac{1}{N} - \frac{1}{eN_o} = 5(t-1)$$

$$\frac{N_o}{N} = 5N_o(t-1) + \frac{1}{e}$$

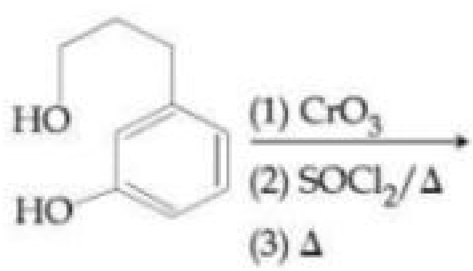
$$\frac{N_o}{N} = 5N_o t + (\frac{1}{e} - 5N_o)$$

This equation is similar to the straight-line equation (Y=mx+C

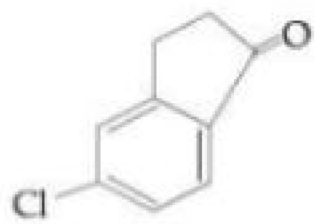
So, the curve will be a straight line and the slope will be posi

∴ Option (3) is correct.

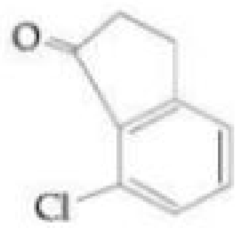
Q. 26 The major product of the following reaction is :



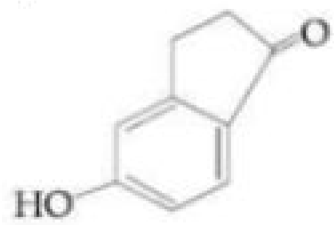
Option 1:



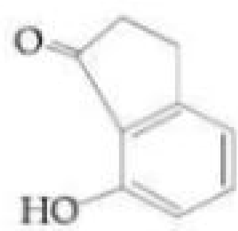
Option 2:



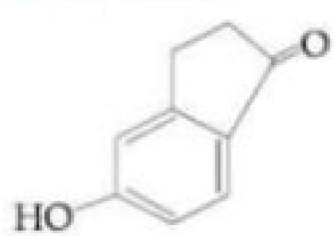
Option 3:



Option 4:

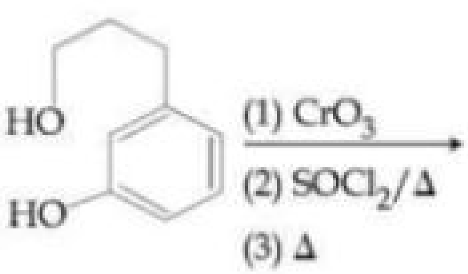


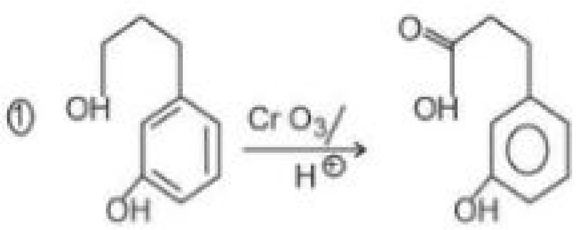
Correct Answer:

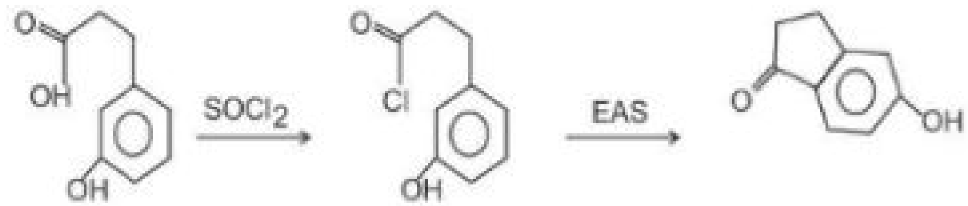


Solution:

CrO3 is a strong oxidising agent and converts alcohol to acids





② 

∴ Option (3) is correct

Q. 27 The potential (in V) of a hydrogen electrode $(P_{H_2} = 1\ atm)$ in a solution with pH = 5 at 25oC is :

Option 1:
0.295

Option 2:
-0.295

Option 3:
-0.59

Option 4:
0.59

Correct Answer:
-0.295

Solution:

$$E = 0 - 0.059 \log\left(\frac{1}{[H^+]}\right)$$

$$\mathrm{E} = -0.059 \times \mathrm{pH}$$
$$\mathrm{E} = -0.059 \times 5 = -0.295\ \mathrm{V}$$

Therefore, option (2) is correct

Q. 28 A first order reaction has a rate constant $k = 5.5 \times 10^{-14}\ s^{-1}$, calculate the Half life of the reaction?

Option 1:
$1.26 \times 10^{13}\ \mathrm{s}$

Option 2:
$0.693 \times 10^{14}\ \mathrm{s}$

Option 3:
$6.93 \times 10^{14}\ \mathrm{s}$

Option 4:
$12.6 \times 10^{14}\ \mathrm{s}$

Correct Answer:
$1.26 \times 10^{13}\ \mathrm{s}$

Solution:

As we have learnt,

Half life for a rst order reaction is given as:

$$\mathrm{t}_{1/2} = \frac{0.693}{\mathrm{k}} = \frac{0.693}{5.5 \times 10^{-14} \mathrm{s}^{-1}} = 1.26 \times 10^{13}\ \mathrm{s}$$

Therefore option (1) is correct

Q. 29 Match the following:

(i) Ribo avin	(a) Beriberi
(ii) Thiamine	(b) Scurvy
(iii) Pyridoxine	(c) Cheilosis
(iv) Ascorbic acid	(d) Convulsions

Option 1:
$(i)-(a),\ (ii)-(b),\ (iii)-(c),\ (iv)-(d)$

Option 2:
$(i)-(c),\ (ii)-(a),\ (iii)-(d),\ (iv)-(b)$

Option 3:
$(i)-(c),\ (ii)-(d),\ (iii)-(a),\ (iv)-(b)$

Option 4:
$(i)-(d),\ (ii)-(b),\ (iii)-(a),\ (iv)-(c)$

Correct Answer:
$(i)-(c),\ (ii)-(a),\ (iii)-(d),\ (iv)-(b)$

Solution:

Vitamin A_1 - Night blindness , Xeropthalmia

Vitamin B_1 (Thiamine) - Beriberi

Vitamin B_2 (Riboflavin) - Cheilosis

Vitamin B_3 (Niacin) - Pellagra

Vitamin B_6 (Pyridoxine) - Convulsions , Anaemia

Vitamin B_{12} - Pernicious anaemia

Vitamin C (Ascorbic acid) - Scurvy

Vitamin d - Rickets (in chilldrens)

Osteomalacia (in adults)

Vitamin E - Increased RBCs fragility , muscular weakness

Vitamin K - Poor blood clotting

-

(i) Ribo avin - (c) Cheilosis
(ii) Thiamine - (a) Beriberi
(iii) Pyridoxine - (d) Convulsions
(iv) Ascorbic acid - (b) Scurvy

Therefore, Option(2) is correct.

Q. 30 Consider the complex ions -

trans $[Co(en)_2Cl_2]^+$ (A) and cis $[Co(en)_2Cl_2]^+$ (B)

The correct statement regarding them is :-

Option 1:
Both (A) and (B) cannot be optically active.

Option 2:
Both (A) and (B) can be optically active.

Option 3:
(A) cannot be optically active, but (B) can be optically active

Option 4:
(A) can be optically active, but (B) cannot be optically active

Correct Answer:
(A) cannot be optically active, but (B) can be optically active

Solution:

Trans - $[Co(en)_2Cl_2]$ has plane of symmetry. So it is not optically acti

Cis - $[Co(en)_2Cl_2]$ does not have any plane of symmetry, so it can be

Therefore, Option(3) is correct.

Q. 31 The d-electron configurations of $[Ru(en)_3]\,Cl_2$ and $[Fe(H_2O)_6]\,Cl_2$, respectively are :

Option 1:
$t_{2g}^6\ e_g^0$ and $t_{2g}^6\ e_g^0$

Option 2:
$t_{2g}^4\ e_g^2$ and $t_{2g}^6\ e_g^0$

Option 3:
$t_{2g}^6\ e_g^0$ and $t_{2g}^4\ e_g^2$

Option 4:
$t_{2g}^4\ e_g^2$ and $t_{2g}^4\ e_g^2$

Correct Answer:
$t_{2g}^6\ e_g^0$ and $t_{2g}^4\ e_g^2$

Solution:

$[Ru(en)_3]\,Cl_2$

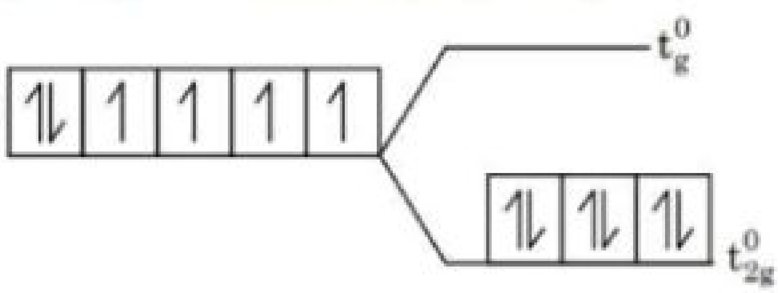
$R_u \Rightarrow$ 4d series

en $\Rightarrow$ chelating ligand

CN = 6, octahedral splitting

hence laye splitting of d-subshell

$R_u^{+2} \Rightarrow [Kr]4d^6 5s^0$

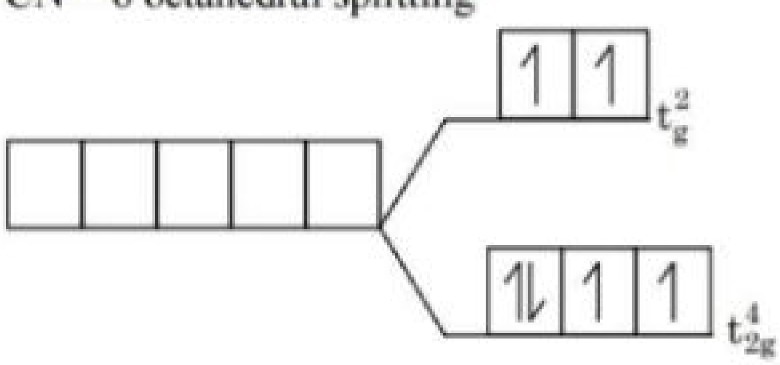


$[Fe(H_2O)_6]Cl_2 \Rightarrow H_2O \Rightarrow$ Weak filled ligand

$Fe^{+2} \Rightarrow [Ar]\,3d^6 4s^0$

less plitting

CN = 6 octahedral splitting



Therefore, Option 3 is correct.

Q. 32 Solution of two components containing n1 moles of 1st c component is prepared, M1 and M2 are molecular weight respectively. If d is the density of the solution in g mL fraction of 2nd component, C2 can be expressed as:

Option 1:

$$c_2 = \frac{dx_2}{M_2 + x_2(M_2 - M_1)}$$

Option 2:

$$c_2 = \frac{dx_1}{M_2 + x_2(M_2 - M_1)}$$

Option 3:

$$c_2 = \frac{1000dx_2}{M_1 + x_2(M_2 - M_1)}$$

Option 4:

$$c_2 = \frac{1000x_2}{M_1 + x_2(M_2 - M_1)}$$

Correct Answer:

$$c_2 = \frac{1000dx_2}{M_1 + x_2(M_2 - M_1)}$$

Solution:

$$\text{Total mass of Component } 1 = n_1M_1$$
$$\text{Total mass of Component } 2 = n_2M_2$$

$$\therefore \text{ Total mass of Solution } = n_1M_1 + n_2M_2$$

$$\therefore \text{ Total mass of Solution } = \frac{n_1M_1 + n_2M_2}{d} \text{ ml} = \frac{n_1M_1 + n_2M_2}{1000d} \text{ litre}$$

$$\therefore C_2 = \frac{n_2}{\frac{n_1M_1 + n_2M_2}{1000d}}$$

$$C_2 = \frac{1000dn_2}{n_1M_1 + n_2M_2}$$

dividing by $(n_1 + n_2)$, we get :

$$C_2 = \frac{1000dx_2}{x_1M_1 + x_2M_2}$$

$$C_2 = \frac{1000dx_2}{M_1 + (M_2 - M_1)x_2}$$

Therefore, Option (3) is correct.

Q. 33 The Crystal Field Stabilization Energy (CFSE) of $[CoF_3(H_2O)_3]$ $(\Delta_0 < P)$ is

Option 1:
$-0.8\Delta_0 + 2P$

Option 2:
$-0.4\Delta_0$

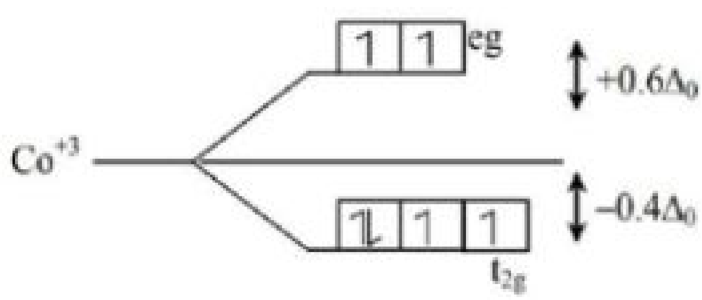
Option 3:
$-0.8\Delta_0$

Option 4:
$-0.4\Delta_0 + P$

Correct Answer:
$-0.4\Delta_0$

Solution:
$[CoF_3(H_2O)_3]$ $(\Delta_0 < P)$ Means all ligands behaves as weak field ligands

So Co^{3+} $(3d^6) = t_{2g}^4 e_g^2$



$$\text{CFSE} = [-0.4 \times 4 + 0.6 \times 2]\Delta_0$$

$$\text{CFSE} = [-1.6 + 1.2]\Delta_0$$

$$\text{CFSE} = [-0.4\Delta_0]$$

Therefore, the correct option is (2).

Q. 34 A flask contains a mixture of compounds A and B. Both c
order kinetics. The half-lives are 300 s and 180 s, A and B respectively. If the
concentrations of A and B are equal initially, the time r
be four times that of B (in s) is : (Use ln 2 = 0.693)

Option 1:
180

Option 2:
900

Option 3:
300

Option 4:
120

Correct Answer:
900

Solution:
We know this for rst-order reactions-

$$A_t = A_0 \cdot e^{-k_1 t}$$

$$B_t = B_0 \cdot e^{-k_1 t}$$

So, half-lives

$$k_1 = \frac{\ln 2}{300}$$

$$k_2 = \frac{\ln 2}{180}$$

The concentration of A to be four times that of B

So, At and Bt are related as [A] = 4[B]

$$A_0 \cdot e^{-k_1 t} = 4 \times B_0 \cdot e^{-k_2 t}$$

If the concentrations of A and B are equal initially, A0 = B0

Then,

$$e^{-k_1 t} = 4e^{-k_2 t}$$

$$e^{(k_2 - k_1)t} = 4$$

$$(k_2 - k_1)t = \ln 4$$

$$\left(\frac{\ln 2}{180} - \frac{\ln 2}{300}\right) t = 2\ln 2$$

$$\frac{t}{180} - \frac{t}{300} = 2$$

$$\frac{t}{3} - \frac{t}{5} = 120$$

$$\frac{2t}{15} = 120$$

t = 900 sec

Therefore, the correct option is (2).

Q. 35 The number of isomers possible for $[Pt(en)(NO_2)_2]$

Option 1:
2

Option 2:
4

Option 3:
1

Option 4:
3

Correct Answer:
2

Solution:
$[Pt(en)(NO_2)_2]$ does not show G.I. as well as optical isomerism -

1. Geometrical isomerism does not show due to the steric hind

2. Optical isomerism does not show due to the presence of a p

But, this complex will have three linkage isomers as follows -

1. $[Pt(en)\,(NO_2)_2]$

2. $[Pt(en)\,(NO_2)\,(ONO)]$

3. $[Pt(en)(ONO)_2]$

So, other than $[Pt(en)(NO_2)_2]$ this, there are 2 isomer is possible.

Ans = 2

Therefore, the correct option is (1).

Q. 36 The pair in which both the species have the same magne

Option 1:
$[Cr(H_2O)_6]^{2+}$ and $[Fe(H_2O)_6]^{2+}$

Option 2:
$[Co(OH)_4]^{2-}$ and $[Fe(NH_3)_6]^{2+}$

Option 3:
$[Mn(H_2O)_6]^{2+}$ and $[Cr(H_2O)]^{2+}$

Option 4:
$[Cr(H_2O)_6]^{2+}$ and $[CoCl_4]^{2-}$

Correct Answer:
$[Cr(H_2O)_6]^{2+}$ and $[Fe(H_2O)_6]^{2+}$

Solution:

For solving need to know the concept of WFL (weak eld ligan
Electronic con guration and unpaired electrons of given comp

Complex	e^- configuration	no. of unpaired e^-
$[Mn(H_2O)_6]^{2+}$	↑ ↑ eg	5
WFL	↑ ↑ ↑ t2g	
$[Cr(H_2O)_6]^{2+}$	↑ eg	4
WFL	↑ ↑ ↑	
$[COCl_4]^{2-}$	↑ ↑ ↑ t2	3
Tetrahedral	↑↓ ↑↓ e	
$[Fe(H_2O)_6]^{2+}$	↑ ↑ eg	4
WFL	↑↓ ↑ ↑ t2g	
$[Co(OH)_4]^{2-}$	↑ ↑ ↑ t2	3
WFL	↑↓ ↑↓ e	
Tetrahedral	↑ ↑	4
$[Fe(NH_3)_6]^{2+}$	↑↓ ↑ ↑	

Thus complex $[Cr(H_2O)_6]^{2+}$ and $[Fe(H_2O)_6]^{2+}$ have the same no. of unpaired e- and
moment (spin only).

Therefore, the correct option is (1).

Q. 37 The complex that can show optical activity is:

Option 1:
trans $-[Cr(Cl_2(ox)_2]^{3-}$

Option 2:
trans- $[Fe(NH_3)_2(CN)_4]^{-}$

Option 3:

$cis-[CrCl_2(ox)_2]^{3-}$ (ox = oxalate)

Option 4:

$cis-[Fe(NH_3)_2(CN)_4]^{-}$

Correct Answer:

$cis-[CrCl_2(ox)_2]^{3-}$ (ox = oxalate)

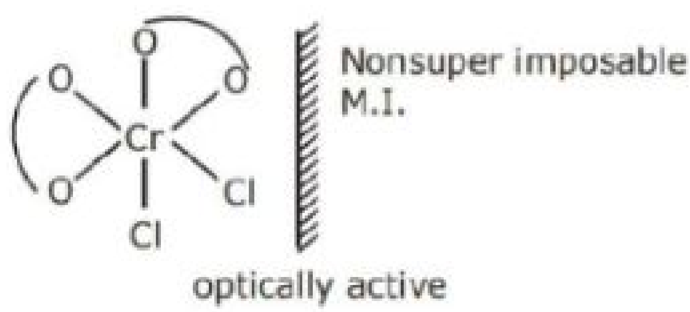
Solution:

The complex that can show optical activity is:

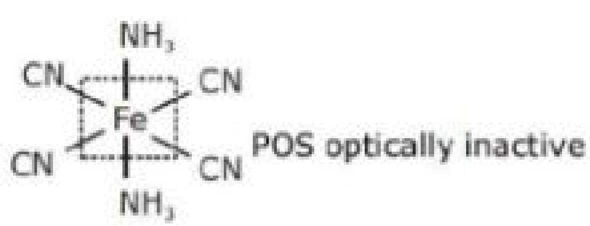
$cis-[CrCl_2(ox)_2]^{3-}$ (ox = oxalate)

The structure is given below:

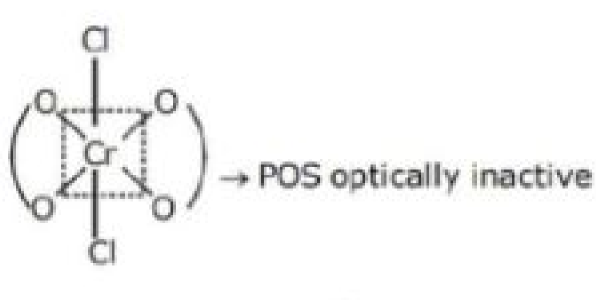
This compound has 2 forms, i.e, d, and l. Hence it is optically



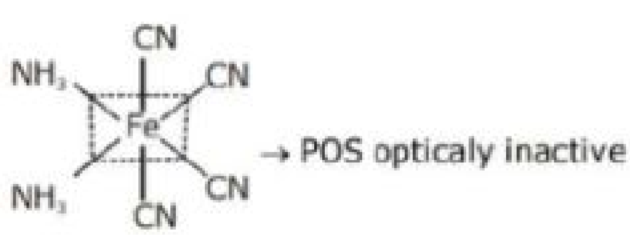
$cis-[CrCl_2(ox)_2]^{3-}$ (ox = oxalate)



$trans-[Fe(NH_3)_2(CN)_4]^{-}$



$trans-[Cr(Cl_2)(ox)_2]^{3-}$



$cis-[Fe(NH_3)_2(CN)_4]^{-}$

Therefore, Option(3) is correct.

Q. 38 The hybridization and magnetic nature of $[Mn(CN)_6]^{4-}$ and $[Fe(CN)_6]^{3-}$, respectively are:

Option 1:
d^2sp^3 and diamagnetic

Option 2:
sp^3d^2 and diamagnetic

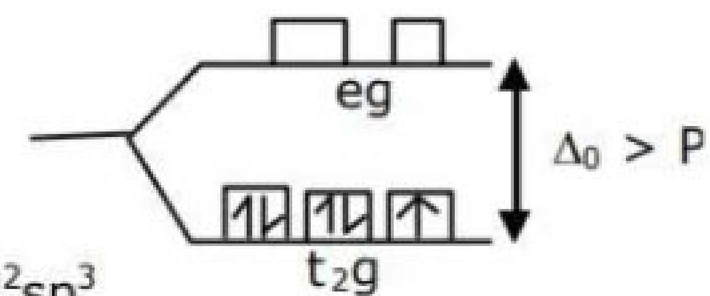
Option 3:
d^2sp^3 and paramagentic

Option 4:
sp^3d^2 and paramagentic

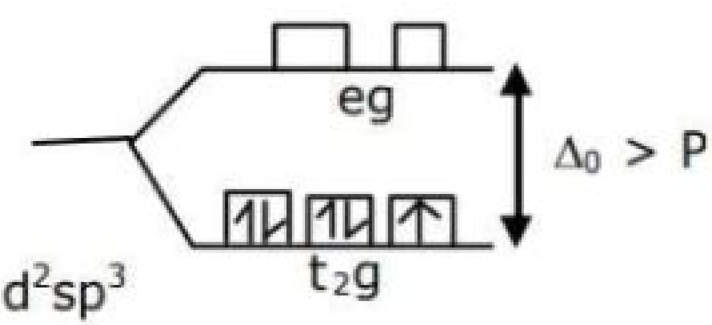
Correct Answer:
d^2sp^3 and paramagentic

Solution:

1. $(Mn(CN)_6)^{4-}$
$Mn^{++} = 3d^5$
$\mu = \sqrt{3}$
hybridization $= d^2sp^3$



2. $[Fe(CN)_6]^{3-}$
$Fe^{3+} = 3d^5$
$\mu = \sqrt{3}$
Hybridization – d^2sp^3



hybridization is d2sp3

and magnetic nature is paramagnetic due to $\mu \neq 0$

Therefore, Option 3 is correct.

Q. 39 The functions of antihistamine are :

Option 1:
Antiallergic and Analgesic

Option 2:
Antiallergic and antidepressant

Option 3:
Antacid and antiallergic

Option 4:
Analgesic and antacid

Correct Answer:
Antacid and antiallergic

Solution:
The functions of antihistamine are Antacid and antiallergic.

Q. 40 Which of the folllowing is least basic?

Option 1:
$(C_2H_5)_2\ddot{N}H$

Option 2:
$(CH_3CO)_2\ddot{N}H$

Option 3:
$(C_2H_5)_3\ddot{N}$

Option 4:
$(CH_3CO)\ddot{N}HC_2H_5$

Correct Answer:
$(CH_3CO)_2\ddot{N}H$

Solution:

For the given compounds :

(1) $CH_3-CH_2-\ddot{N}H-CH_2-CH_3$; L.P. on Nitrogen is localised.

(2) $CH_3-\underset{\|}{\overset{}{C}}-\ddot{N}H-\underset{\|}{C}-CH_3$ (with $C=O$ on both carbons) ; L.P. on Nitrogen is

delocalised due to conjugation with both $-\underset{\underset{O}{\|}}{C}-$

(Hence least basic)

(3) $CH_3CH_2-\underset{\underset{CH_2CH_3}{|}}{\ddot{N}}-CH_2CH_3$; L.P. on Nitrogen is localised.

(4) $CH_3-\overset{\overset{O}{\|}}{C}-\ddot{N}H-C_2H_5$; L.P. on Nitrogen is delocalised.

Therefore, Option 2 is correct.

Maths

Q. 1 If $\sin^{-1}x+\sin^{-1}y+\sin^{-1}z=\frac{\pi}{2}$ then the value of $x^2+y^2+z^2+2xyz$ is

Correct Answer:
1

Solution:
$\sin^{-1}x+\sin^{-1}y+\sin^{-1}z=\frac{\pi}{2}$
Put $\sin^{-1}x=A, \sin^{-1}y=B, \sin^{-1}z=C$
$A+B+C=\frac{\pi}{2}$
$A+B=\frac{\pi}{2}-C$
$\cos(A+B)=\cos(\frac{\pi}{2}-C)$
$\cos A\cos B-\sin A\sin B=\sin C$
we have $\sin A=x, \cos A=\sqrt{1-x^2}, \; and \; similarly, \cos B=\sqrt{1-y^2}$
$\sqrt{1-x^2}\cdot\sqrt{1-y^2}-xy=z$
$(1-x^2)(1-y^2)=x^2y^2+z^2+2xyz$
$x^2+y^2+z^2+2xyz=1$

Q. 2 Find the number of the solution of x if $\sin(2\sin^{-1}x)=1$

Correct Answer:
1

Solution:

$Let\ \sin^{-1}(x) = \theta$
$\sin(2\sin^{-1} x) = 1$
$\sin(2\theta) = 1$
$2\sin\theta.\cos\theta = 1$
$Now, as\ \sin^{-1}(x) = \theta, so\ \sin(\theta) = x, \cos(\theta) = \sqrt{1-x^2}$
$2x\sqrt{1-x^2} = 1$
$4x^2(1-x^2) = 1$
$4x^2 - 4x^4 - 1 = 0$
$x = \pm\frac{1}{\sqrt{2}}$
But $\frac{-1}{\sqrt{2}}$ is not satisfying first equation, it is extra root generated beacuse of squaring the eqaution
$Hence,\ x = \frac{1}{\sqrt{2}}$

Q. 3 Calculate the value of k if $\cos^{-1}\frac{1}{3} + \cos^{-1}\frac{2}{3} = \cos^{-1} x$

Option 1:
$\pi + \frac{1}{9}(2 - 2\sqrt{10})$

Option 2:
$\frac{1}{9}(2 - 2\sqrt{10})$

Option 3:
$\frac{1}{9}(2 + 2\sqrt{10})$

Option 4:
$2\pi + \frac{1}{9}(2 - 2\sqrt{10})$

Correct Answer:
$\frac{1}{9}(2 - 2\sqrt{10})$

Solution:
Sum and di erence of angles in terms of arccos

$$cos^{-1}x + \cos^{-1} y = \cos^{-1}\{xy - \sqrt{1-x^2}\sqrt{1-y^2}\} \ \text{ if } 0 < x, y \le 1$$

Now,

$$\cos^{-1}\frac{1}{3}+\cos^{-1}\frac{2}{3}=\cos^{-1}x$$
$$\cos^{-1}\{\frac{1}{3}\times\frac{2}{3}-\sqrt{1-(\frac{1}{3})^2}\sqrt{1-(\frac{2}{3})^2}\ \}=\cos^{-1}x$$
$$\cos^{-1}\{\frac{1}{9}(2-2\sqrt{10})\}=\cos^{-1}x$$
$$x=\frac{1}{9}(2-2\sqrt{10})$$

Q. 4 Let $A=\begin{bmatrix}1 & 2\\ -1 & 4\end{bmatrix}$. If $A^{-1}=\alpha I+\beta A, \alpha, \beta \in \mathbf{R}$, $\mathbf{I}$ is a 2×2 identity matrix, then $4(\alpha-\beta)$ is equal to :

Option 1:
5

Option 2:
$\frac{8}{3}$

Option 3:
2

Option 4:
4

Correct Answer:
4

Solution:

$$Given A=\begin{bmatrix}1 & 2\\ -1 & 4\end{bmatrix}$$

$$\Rightarrow |A|=4+2=6, so\ \ inverse\ \ exists$$

$$Now A^{-1}=\frac{\operatorname{adj}(A)}{|A|}=\frac{1}{6}\begin{bmatrix}4 & -2\\ 1 & 1\end{bmatrix}$$
$$=\begin{bmatrix}\frac{2}{3} & -\frac{1}{3}\\ \frac{1}{6} & \frac{1}{6}\end{bmatrix}$$

$$\text{As}\quad A^{-1}=\alpha I+\beta A$$

$$\Rightarrow\begin{bmatrix}\frac{2}{3} & -\frac{1}{3}\\ \frac{1}{6} & \frac{1}{6}\end{bmatrix}=\begin{bmatrix}\alpha & 0\\ 0 & \alpha\end{bmatrix}+\begin{bmatrix}\beta & 2\beta\\ -\beta & 4\beta\end{bmatrix}\Rightarrow\begin{bmatrix}\frac{2}{3} & -\frac{1}{3}\\ \frac{1}{6} & \frac{1}{6}\end{bmatrix}=\begin{bmatrix}\alpha+\beta & 2\beta\\ -\beta & \alpha+4\beta\end{bmatrix}$$

$$\therefore\quad -\beta=\frac{1}{6}\Rightarrow\beta=-\frac{1}{6}\ \text{and}$$

$\alpha+\beta=\frac{2}{3} \Rightarrow \alpha=\frac{5}{6}$

$\therefore \quad 4(\alpha-\beta)=4\left(\frac{5}{6}+\frac{1}{6}\right)=4$

Hence option (4) is correct answer

Q.5 The values of λ and μ such that the system of equations $x+y+z=6, 3x+5y+5z=26, x+2y+\lambda z=\mu$ has no solution, are :

Option 1:
$\lambda=3, \mu=5$

Option 2:
$\lambda=3, \mu \neq 10$

Option 3:
$\lambda \neq 2, \mu=10$

Option 4:
$\lambda=2, \mu \neq 10$

Correct Answer:
$\lambda=2, \mu \neq 10$

Solution:

$x+y+z=6$

$3x+5y+5z=26$

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

$$\Delta=0 \Rightarrow\left|\begin{array}{lll}1 & 1 & 1 \\ 3 & 5 & 5 \\ 1 & 2 & h\end{array}\right|=0$$

$\Rightarrow 5h-10-3h+5+1=0 \Rightarrow h=2.$

Only option (4) has $h=2.$

Hence option (4) is correct.

Q.6 The solutions of the equation

$$\left|\begin{array}{ccc}1+\sin^2 x & \sin^2 x & \sin^2 x \\ \cos^2 x & 1+\cos^2 x & \cos^2 x \\ 4\sin 2x & 4\sin 2x & 1+4\sin 2x\end{array}\right|=0,(0<x<\pi)$$ are :

Option 1:
$\frac{\pi}{12}, \frac{\pi}{6}$

Option 2:
$\frac{7\pi}{12}, \frac{11\pi}{12}$

Option 3:
$\frac{5\pi}{12}, \frac{7\pi}{12}$

Option 4:
$\frac{\pi}{6}, \frac{5\pi}{6}$

Correct Answer:
$\frac{7\pi}{12}, \frac{11\pi}{12}$

Solution:
$R_1 \rightarrow R_1 + R_2 + R_3$

$$\begin{vmatrix} 1+\sin^2 x & \sin^2 x & \sin^2 x \\ \cos^2 x & 1+\cos^2 x & \cos^2 x \\ 4\sin 2x & 4\sin 2x & 1+4\sin 2x \end{vmatrix} = 0$$

$$\begin{vmatrix} 1+\sin^2 x+\cos^2 x+4\sin 2x & \sin^2 x+1+\cos^2 x+4\sin 2x & \sin^2 x+\cos^2 x+1+4\sin 2x \\ \cos^2 x & 1+\cos^2 x & \cos^2 x \\ 4\sin 2x & 4\sin 2x & 1+4\sin 2x \end{vmatrix} = 0$$

$$\Rightarrow (2+4\sin 2x)\begin{vmatrix} 1 & 1 & 1 \\ \cos^2 x & 1+\cos^2 x & \cos^2 x \\ 4\sin 2x & 4\sin 2x & 1+4\sin 2x \end{vmatrix} = 0$$

$\Rightarrow \sin 2x = -\frac{1}{2}$
$\Rightarrow 2x = \pi + \frac{\pi}{6}, 2\pi - \frac{\pi}{6}$
$x = \frac{\pi}{2} + \frac{\pi}{12}, \pi - \frac{\pi}{12}$

Q. 7

The maximum value of $f(x) = \begin{vmatrix} \sin^2 x & 1+\cos^2 x & \cos 2x \\ 1+\sin^2 x & \cos^2 x & \cos 2x \\ \sin^2 x & \cos^2 x & \sin 2x \end{vmatrix}, x \epsilon R$ is

Option 1:
5

Option 2:
$\sqrt{7}$

Option 3:
$\sqrt{5}$

Option 4:
$\frac{3}{4}$

Correct Answer:
$\sqrt{5}$

Solution:
$$\begin{vmatrix} \sin^2 x & 1+\cos^2 x & \cos 2x \\ 1+\sin^2 x & \cos^2 x & \cos 2x \\ \sin^2 x & \cos^2 x & \sin 2x \end{vmatrix}$$
$C_1 \to C_1 - C_2$
$$\begin{vmatrix} 2 & 1+\cos^2 x & \cos 2x \\ 2 & \cos^2 x & \cos 2x \\ 1 & \cos^2 x & \sin 2x \end{vmatrix}$$
$R_1 \to R_1 - R_2$
$$\begin{vmatrix} 0 & 1 & 0 \\ 2 & \cos^2 x & \cos 2x \\ 1 & \cos^2 x & \sin 2x \end{vmatrix}$$
Open w.r.t. R_1
$-(2\sin 2x - \cos 2x)$
$\cos 2x - 2\sin 2x = f(x)$
$f(x)|_{\max} = \sqrt{1+4} = \sqrt{5}$

Q.8 The system of equations $kx+y+z=1$, $x+ky+z+=k$ and $x+y+zk=k^2$ has no solution if k is equal to :

Option 1:
0

Option 2:
-2

Option 3:
-1

Option 4:

1

Correct Answer:

-2

Solution:

$kx+y+z=1$
$x+ky+z=k$
$x+y+zk=k^2$

$$\Delta=\begin{vmatrix}k & 1 & 1\\ 1 & k & 1\\ 1 & 1 & k\end{vmatrix}=k\left(k^2-1\right)-1(k-1)+1(1-k)$$

$=k^3-k-k+1+1-k$
$=k^3-3k+2$
$=(k-1)^2(k+2)$
For $k=1$
$\Delta=\Delta_1=\Delta_2=\Delta_3=0$

But for k = -2, at least $\Delta_1, \Delta_2, \Delta_3$ are not equal to zero

Hence for no solution, k = -2

Q. 9 The value of $\begin{vmatrix}(a+1)(a+2) & a+2 & 1\\ (a+2)(a+3) & a+3 & 1\\ (a+3)(a+4) & a+4 & 1\end{vmatrix}$ is :

Option 1:

-2

Option 2:

0

Option 3:

$(a+1)(a+2)(a+3)$

Option 4:

$(a+2)(a+3)(a+4)$

Correct Answer:

-2

Solution:

put a = 0, we get

$$\Delta = \begin{vmatrix} (a+1)(a+2) & a+2 & 1 \\ (a+2)(a+3) & a+3 & 1 \\ (a+3)(a+4) & a+4 & 1 \end{vmatrix} = \begin{vmatrix} 2 & 2 & 1 \\ 6 & 3 & 1 \\ 12 & 4 & 1 \end{vmatrix}$$

$$\Delta = 2(3-4) - 2(6-12) + 1(24-36) = -2$$

OR

Given matrix is

$$\Delta = \begin{vmatrix} (a+1)(a+2) & a+2 & 1 \\ (a+2)(a+3) & a+3 & 1 \\ (a+3)(a+4) & a+4 & 1 \end{vmatrix}$$

$R_2 \rightarrow R_2 - R_1$ and $R_3 \rightarrow R_3 - R_1$

$$\Delta = \begin{vmatrix} (a+1)(a+2) & a+2 & 1 \\ (a+2)(a+3-a-1) & 1 & 0 \\ a^2+7a+12-a^2-3a-2 & 2 & 0 \end{vmatrix}$$

$$= \begin{vmatrix} a^2+3a+2 & a+2 & 1 \\ 2(a+2) & 1 & 0 \\ 4a+10 & 2 & 0 \end{vmatrix}$$

$=4(a+2) - 4a - 10$

$=4a + 8 - 4a - 10 = -2$

Q. 10 Let $f : \mathbf{R} \rightarrow \mathbf{R}$ be defined as $f(x) = \begin{cases} -\frac{4}{3}x^3 + 2x^2 + 3x & , x > 0 \\ 3xe^x & , x \le 0 \end{cases}$. Then f is increasing function in the

Option 1:
$\left(-\frac{1}{2}, 2\right)$

Option 2:
$(0, 2)$

Option 3:
$\left(-1, \frac{3}{2}\right)$

Option 4:
$(-3, -1)$

Correct Answer:
$\left(-1, \frac{3}{2}\right)$

Solution:

LHL at $(x=0)$ = RHL at $(x=0)$

So $f(x)$ is a continuous function

Now $f'(x)=\begin{cases}-4x^2+4x+3, & x>0\\ 3xe^x+3e^x, & x\leqslant 0\end{cases}$

For $x\leq 0$, $f'(x)=3e^x(x+1)$

$f'(x)>0 \Rightarrow x>-1$

For $x>0$, $f'(x)=-4x^2+4x+3.$

$$=-(2x+1)(2x-3).$$

$$So\ f'(x)>0 \Rightarrow x\epsilon\left(0,\frac{3}{2}\right)$$

$So\ f'(x)$ is increasing in $\left(-1,\frac{3}{2}\right)$

Hence option (3) is correct.

Q. 11 Let $f:\mathbf{R}\rightarrow\mathbf{R}$ be defined as

$$f(x)=\begin{cases}\frac{x^3}{(1-\cos 2x)^2}\log_e\left(\frac{1+2xe^{-2x}}{(1-xe^{-x})^2}\right), & x\neq 0\\ \alpha & , x=0\end{cases}$$

If f is continuous at $x=0$, then α is equal to:

Option 1:
1

Option 2:
3

Option 3:
0

Option 4:
2

Correct Answer:
1

Solution:

For $f(x)$ to be continuous at $x=0$

$\lim_{x\to 0} f(x)=f(0)$

$$\Rightarrow \lim_{x \to 0} \frac{x^3}{(1-\cos 2x)^2} \ln\left(\frac{1+2xe^{-2x}}{1-xe^{-x})^2}\right) = \alpha$$

$$\Rightarrow \lim_{x \to 0} \frac{x^3}{4\sin^4 x}\left[\ln\left(1+2xe^{-2x}\right) - 2\ln\left(1-xe^{-x}\right)\right] = \alpha$$

$$\Rightarrow \lim_{x \to 0} \frac{x^4}{4\sin^4 x} \cdot \frac{\ln\left(1+2xe^{-2x}\right)}{x \cdot \left(2xe^{-2x}\right)}\left(2xe^{-2x}\right)$$

$$-\lim_{x \to 0} \frac{2}{4} \frac{x^4}{\sin^{4x}} \frac{\ln\left(1-xe^{-x}\right)\left(-xe^{-x}\right)}{x\left(-xe^{-x}\right)} = \alpha.$$

$$\Rightarrow \frac{1}{2} - \left(-\frac{1}{2}\right) = \alpha$$

$$\Rightarrow \alpha = 1$$

Hence, the correct answer is option (1)

Q. 12 Let the functions $f : R \to R$ and $g : R \to R$ be defined as :

$$f(x) = \begin{cases} x+2, & x < 0 \\ x^2, & x \geqslant 0 \end{cases} \text{ and } g(x) = \begin{cases} x^3, & x < 1 \\ 3x-2, & x \geqslant 1 \end{cases}$$

Then, the number of points in R where $(f \circ g)(x)$ is NOT differentiable is equal

Option 1:
2

Option 2:
0

Option 3:
3

Option 4:
1

Correct Answer:
1

Solution:

$$f(x) = \begin{cases} x+2, & x < 0 \\ x^2, & x \geq 0 \end{cases} \text{ and } g(x) = \begin{cases} x^3, & x < 1 \\ 3x-2, & x \geq 1 \end{cases}$$

$$f(g(x)) = \begin{cases} g(x)+2, & g(x)<0 \\ (g(x))^2, & g(x)\ge 0 \end{cases}$$

$$= \begin{cases} x^3+2, & x<0 \\ x^6, & x\in[0,1) \\ (3x-2)^2, & x\in[1,\infty) \end{cases}$$

$$(f\circ g(x))' = \begin{cases} 3x^2, & x<0 \\ 6x^5, & x\in(0,1) \\ 2(3x-2)\times 3, & x\in(1,\infty) \end{cases}$$

At x = 0

L.H.L. is not equal to R.H.L. (Discontinuous)

At x = 1

L.H.L. = 6 = R.H.L.

$\Rightarrow f\,\mathrm{og(x)}$ is differentiable for $\mathrm{x} \in \mathbb{R} - \{0\}$

Hence option (4)is correct

Q. 13 Let $f(x) = x\cos^{-1}(-\sin|x|),\ x \in \left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$, then which of the following

Option 1:
$f'(0) = -\frac{\pi}{2}$.

Option 2:
f' is decreasing in $\left(-\frac{\pi}{2}, 0\right)$ and increasing in $\left(0, \frac{\pi}{2}\right)$

Option 3:
f is not di erentiable at $x = 0$

Option 4:
f' is increasing in $\left(-\frac{\pi}{2}, 0\right)$ and decreasing in $\left(0, \frac{\pi}{2}\right)$

Correct Answer:
f' is decreasing in $\left(-\frac{\pi}{2}, 0\right)$ and increasing in $\left(0, \frac{\pi}{2}\right)$

Solution:

Application of Monotonicity (Part 1) -

-

$$f'(x) = x\left(\pi - \cos^{-1}(\sin|x|)\right)$$
$$= x\left(\pi - \left(\frac{\pi}{2} - \sin^{-1}(\sin|x|)\right)\right)$$
$$= x\left(\frac{\pi}{2} + |x|\right)$$

$$f(x) = \begin{cases} x\left(\frac{\pi}{2} + x\right) & x \geq 0 \\ x\left(\frac{\pi}{2} - x\right) & x < 0 \end{cases}$$
$$f'(x) = \begin{cases} \frac{\pi}{2} + 2x & x \geq 0 \\ \frac{\pi}{2} - 2x & x < 0 \end{cases}$$

$f'(x)$ is increasing in $\left(0, \frac{\pi}{2}\right)$ and decreasing in $\left(\frac{-\pi}{2}, 0\right)$

Correct Option (2)

Q. 14 Let f be any function continuous on $[a, b]$ and twice differentiable on (a, b). If for all $x \epsilon (a, b)$, $f'(x) > 0$ and $f''(x) < 0$, then for any $c \epsilon (a, b)$, $\frac{f(c) - f(a)}{f(b) - f(c)}$ is greater than :

Option 1:
$\frac{b - c}{c - a}$

Option 2:
1

Option 3:
$\frac{c - a}{b - c}$

Option 4:
$\frac{b + a}{b - a}$

Correct Answer:
$\frac{c - a}{b - c}$

Solution:

Lagrange's Mean Value Theorem -

Lagrange's Mean Value Theorem

Rolle's theorem is a special case of the Mean Value Theorem. di erentiable functions f de ned on a closed interval [a, b] wi generalized Rolle's theorem by considering functions that do endpoints.

Statement

Let f (x) be a function de ned on [a, b] such that

1. it is continuous on [a, b],
2. it is di erentiable on (a, b).

Then there exists a real number c (a, b) such that

$$f'(c)=\frac{f(b)-f(a)}{b-a}$$

Cauchy's mean value Theorem

Cauchy's mean value theorem, also known as the extended me function f(x) and g(x) are continuous on the closed interval [a (a, b) and g'(x) is not zero on that open interval, then there

$$\frac{f'(c)}{g'(c)}=\frac{f(b)-f(a)}{g(b)-g(a)}$$

-

Use LMVT for x ∈ [a, c]

$$\frac{\mathrm{f(c)-f(a)}}{\mathrm{c-a}}=\mathrm{f}'(\alpha), \alpha \in (\mathrm{a,c})$$

also use LMVT for x ∈ [c, b]

$$\frac{f(b)-f(c)}{b-c}=f'(\beta), \beta \in (c,b)$$

$\because f''(x) \Rightarrow f'(x)$ is decreasing

$f'(\alpha) > f'(\beta)$

$\frac{f(c)-f(a)}{c-a} > \frac{f(b)-f(c)}{b-c}$

$\frac{f(c)-f(a)}{f(b)-f(c)} > \frac{c-a}{b-c} (\because f(x) \text{ is increasing})$

Q. 15 If a line, y=mx+c is a tangent to the circle $(x-3)^2+y^2=1$ and it is perpendicular to a line L_1, where L_1 is the tangent to the circle $x^2+y^2=1$ at the point $\left(\frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}}\right)$; then :

Option 1:
$c^2+7c+6=0$

Option 2:
$c^2-6c+7=0$

Option 3:
$c^2-7c+6=0$

Option 4:
$c^2+6c+7=0$

Correct Answer:
$c^2+6c+7=0$

Solution:

Slope and Equation of Tangent -

Tangent and Normal

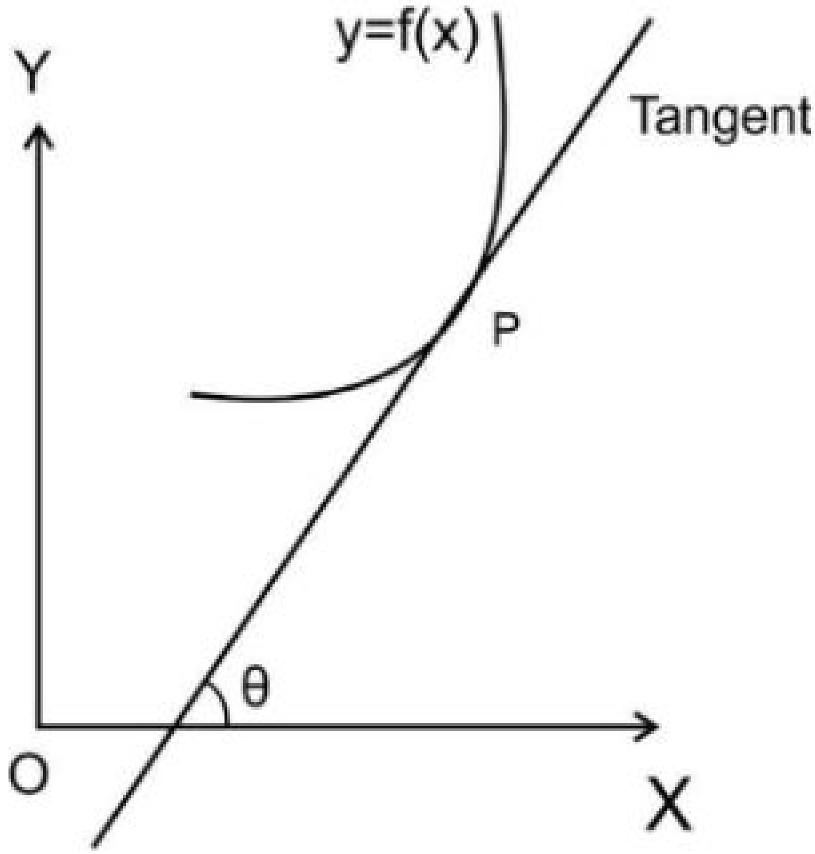
Slope and Equation of Tangent:

Let P(x0, y0) be a point on the continuous curve y = f(x), then
P is

$\left(\frac{dy}{dx}\right)_{(x_0, y_0)}$.

$\Rightarrow \left(\frac{dy}{dx}\right)_{(x_0, y_0)} = \tan\theta = \text{ slope of tangent at } P$

Where Θ is the angle which the tangent at P (x makes with th
the gure.



- If the tangent is parallel $\theta = 0$ to x-axis then

$$\Rightarrow \quad \tan\theta = 0$$

$$\therefore \left(\frac{dy}{dx}\right)_{(x_0, y_0)} = 0$$

- If the tangent is perpendicular $\theta = 90$ to x-axis then

$$\Rightarrow \quad \tan\theta \to \infty \quad \text{or} \quad \cot\theta = 0$$

$$\therefore \left(\frac{dx}{dy}\right)_{(x_0, y_0)} = 0$$

Equation of Tangent:

Let the equation of curve y = f (x) and a point P (x0, y0) lies

The slope of the tangent to the curve at a point P is

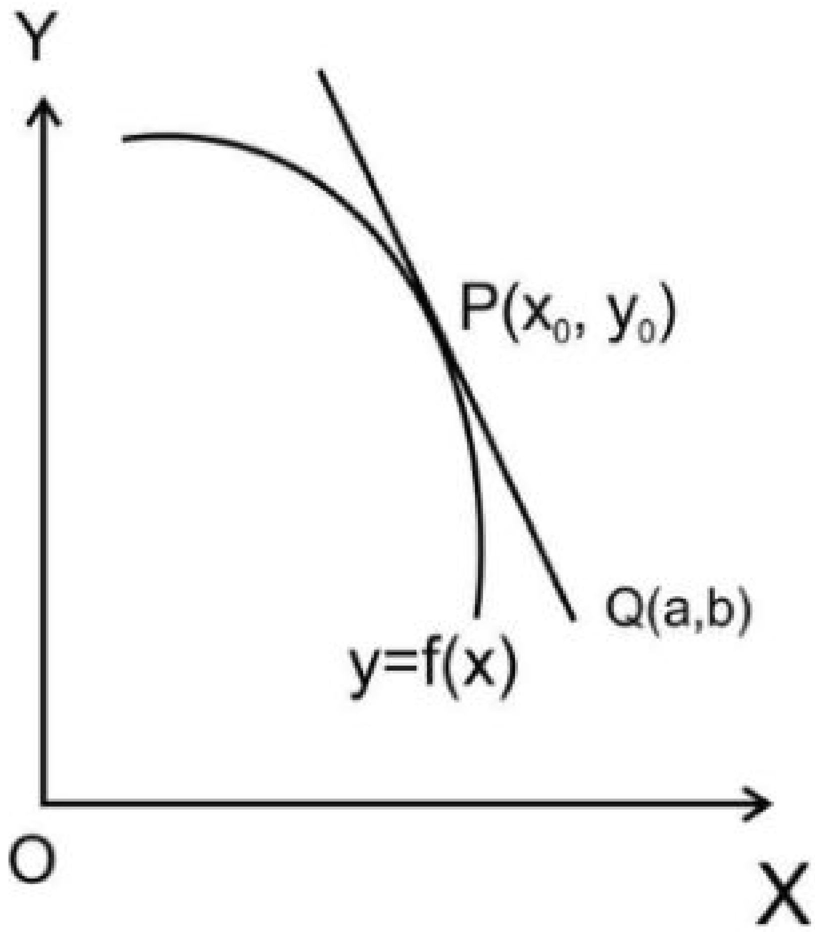
$$\left(\frac{dy}{dx}\right)_{(x_0, y_0)}.$$

Hence, the equation of the tangent at point P is

$$(y - y_0) = \left(\frac{dy}{dx}\right)_{(x_0, y_0)} \cdot (x - x_0)$$

Tangent from External Point:

If a point Q(a, b) does not lie on the curve y = f(x), then the e
f(x) (tangent passing through point Q (a, b)) can be found by
curve.



$P\ (x_0, y_0)$ lies on the curve y = f(x), then

$$y_0 = f(x_0)$$

Also, slope of PQ is

$$\frac{y_0 - b}{x_0 - a} = \left(\frac{dy}{dx}\right)_{(x_0, y_0)}$$

By solving the above two equations we get point of contact po

-

Distance of a Point From a Line -

Distance of a point from a line

Perpendicular length from a point (x1,y1) to the line L : Ax + B

$$\frac{|\mathbf{Ax_1} + +\mathbf{By_1} + \mathbf{C}|}{\sqrt{\mathbf{A^2} + \mathbf{B^2}}}$$

-

The slope of the tangent to $x^2 + y^2 = 1$ at $\left(\frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}}\right)$

$x^2 + y^2 = 1$
$2x + 2yy' = 0$
$y' = -\frac{x}{y} = -1$
$y = mx + c$ is tangent of $x^2 + y^2 = 1$

so m = 1

y = x + c

now distance of (3, 0) from y = x + c is

$\left|\frac{c+3}{\sqrt{2}}\right| = 1$
$c^2 + 6c + 9 = 2$
$c^2 + 6c + 7 = 0$

Correct Option (4)

Q. 16 The value of the de nite integral
$$\int_{-\frac{\pi}{4}}^{\frac{\pi}{4}} \frac{dx}{\left(1+e^{x\cos x}\right)\left(\sin^4 x+\cos^4 x\right)}$$
is equal to:

Option 1:
$-\frac{\pi}{2}$

Option 2:
$\frac{\pi}{2\sqrt{2}}$

Option 3:
$-\frac{\pi}{4}$

Option 4:
$\frac{\pi}{\sqrt{2}}$

Correct Answer:
$\frac{\pi}{2\sqrt{2}}$

Solution:
$$I = \int_{-\pi/4}^{\pi/4} \frac{dx}{\left(1+e^{x\cos x}\right)\left(\sin^4 x+\cos^4 x\right)} - \text{(i)}$$

$UsingKing'sRule.$

$$I=\int_{-\frac{\pi}{4}}^{\pi/4}\frac{dx}{\left(1+e^{-x\cos x}\right)\left(\sin^4 x+\cos^4 x\right)}$$

$$\Rightarrow I=\int_{-\pi/4}^{\pi/4}\frac{e^{x\cos x}}{\left(1+e^{x\cos x}\right)\left(\sin^4 x+\cos^4 x\right)}-\text{ (ii)}$$

(i) + (ii)

$$\Rightarrow 2I=\int_{-\pi/4}^{\pi/4}\frac{dx}{\sin^4 x+\cos^4 x}$$

$$\Rightarrow 2I=2\int_{0}^{\pi/4}\frac{dx}{\sin^4 x+\cos^4 x}$$

$$\Rightarrow I=\int_{0}^{\pi/4}\frac{\left(1+\tan^2 x\right)\sec^2 x dx}{\tan^4 x+1}$$

$Let\ \ \tan x=t\Rightarrow\sec^2 x dx=dt$

$$I=\int_0^1\frac{\left(1+t^2\right)}{\left(1+t^4\right)}dt$$

$$I=\int_0^1\frac{\left(1+\frac{1}{t^2}\right)}{\left(t^2+\frac{1}{t^2}\right)}dt$$

$$I=\int_0^1\frac{\left(1+\frac{1}{t^2}\right)}{\left(t-\frac{1}{t}\right)^2+2}dt$$

$$Let\ t-\frac{1}{t}=u\Rightarrow\left(1+\frac{1}{t^2}\right)dt=du$$

$$I=\int_{-\infty}^{0}\frac{du}{\mu^2+2}$$

$$I=\frac{1}{\sqrt{2}}\tan^{-1}\left(\frac{\mu}{\sqrt{2}}\right)\Big|_{-\infty}^{0}=\frac{\pi}{2\sqrt{2}}$$

Hence option (2) is correct.

Q. 17

The value of $\lim_{n\to\infty}\frac{1}{n}\sum_{j=1}^{n}\frac{(2j-1)+8n}{(2j-1)+4n}$ is equal to :

Option 1:

$5+\log_e\left(\frac{3}{2}\right)$

Option 2:

$2-\log_e\left(\frac{2}{3}\right)$

Option 3:

$3+2\log_e\left(\frac{2}{3}\right)$

Option 4:

$1+2\log_e\left(\frac{3}{2}\right)$

Correct Answer:

$1+2\log_e\left(\frac{3}{2}\right)$

Solution:

$$
\begin{aligned}
S &= \frac{1}{n}\sum\frac{(2j-1)+4n+4n}{(2j-1)+4n} \\
&= \frac{1}{n}\left(\sum 1+\sum\frac{4n}{(2j-1)+4n}\right). \\
&= \frac{1}{n}\sum 1+\frac{1}{n}\sum\frac{4}{2\left(\frac{j}{n}\right)+4-\frac{1}{n}} \\
&= \frac{1}{n}\cdot n+\int_0^1\frac{4}{2x+4}dx \\
&= 1+2\ln|x+2|_0^1 \\
&= 1+2\ln\left(\frac{3}{2}\right)
\end{aligned}
$$

Hence option (4) is correct answer

Q. 18 If $\int_0^{100\pi}\frac{\sin^2 x}{e^{\left(\frac{x}{\pi}-\left[\frac{x}{\pi}\right]\right)}}dx=\frac{\alpha\pi^3}{1+4\pi^2}, \alpha\in\mathbf{R}$ where $[x]$ is the greatest integer less than or equal to x, then the value of α is

Option 1:

$200\left(1-e^{-1}\right)$

Option 2:

$100(1-\mathrm{e})$

Option 3:
$50(e-1)$

Option 4:
$150\left(\mathrm{e}^{-1}-1\right)$

Correct Answer:
$200\left(1-e^{-1}\right)$

Solution:
$$I=\int_0^{100\pi}\frac{\sin^2 x}{e^{\left\{\frac{x}{\pi}\right\}}}$$
Now $e^{\{x\}}$ is periodic with period $=1$

$\Rightarrow e^{\left\{\frac{x}{\pi}\right\}}$ is periodic with period $\frac{1}{1/\pi}=\pi$

$$\therefore I=100\int_0^{\pi}\frac{\sin^2 x}{e^{x/\pi}}dx$$
$$=100\left[\int_0^{\pi}e^{-x/\pi}\left(\frac{1-\cos 2x}{2}\right)dx\right]$$
$$=50\left[\int_0^{\pi}e^{-x/\pi}-\int_0^{\pi}e^{-x/\pi}\cos 2x dx\right]$$
$$=50\left[I_1-I_2\right]\text{ -------- (i)}$$
$$I_1=\int_0^{\pi}e^{-x/\pi}dx=\left[-\pi e^{-x/\pi}\right]_0^{\pi}=\pi\left(1-e^{-1}\right)$$
$$I_2=\int_0^{\pi}e^{-x/\pi}\cos 2x dx.$$
Using integration by parts'
$$I_2=\frac{\pi\left(1-e^{-1}\right)}{1+4\pi^2}$$
$$\therefore (i)\Rightarrow I=50\left(\pi\left(1-e^{-1}\right)-\frac{\pi\left(1-e^{-1}\right)}{1+4\pi^2}\right)$$
$$=\frac{200\left(1-e^{-1}\right)\pi^3}{1+4\pi^2}$$
comparing $\alpha=200\left(1-e^{-1}\right)$

Hence option (1) is correct.

Q. 19 Let $g(t)=\int_{-\pi/2}^{\pi/2}\cos\left(\frac{\pi}{4}t+f(x)\right)dx$, where $f(x)=\log_e\left(x+\sqrt{x^2+1}\right), x\in\mathbf{R}$. Then which one of the following is correct?

Option 1:
$g(1)=g(0)$

Option 2:
$\sqrt{2}g(1)=g(0)$

Option 3:
$g(1)=\sqrt{2}g(0)$

Option 4:
$g(1)+g(0)=0$

Correct Answer:
$\sqrt{2}g(1)=g(0)$

Solution:

$$f(x)=\log\left(x+\sqrt{x^2+1}\right)$$

$$\Rightarrow f(-x)=\log\left(\sqrt{x^2+1}-x\right)$$

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

$$=\log\left(\frac{1}{\sqrt{x^2+1}+x}\right)=-\log\left(\sqrt{x^2+1}+x\right)=-f(x)$$

$\therefore f(-x)=-f(x)\Rightarrow f(x)$ is an odd function.

Now,

$$g(t)=\int_{-\pi/2}^{\pi/2}\cos\left(\frac{\pi t}{4}+f(x)\right)dx$$

$$=\int_{-\pi/2}^{\pi/2}\cos\left(\frac{\pi t}{4}\right)\cdot\cos(f(x))dx+\int_{-\pi/2}^{\pi/2}\sin\left(\frac{\pi t}{4}\right)\sin(f(x))dx.$$

$$=\cos\left(\frac{\pi t}{4}\right)\int_{-\pi/2}^{\pi/2}\cos(f(x))dx+\sin\left(\frac{\pi t}{4}\right)\int_{-\pi/2}^{\pi/2}\sin(f(x))dx.$$

As f(x) is odd $\Rightarrow \sin(f(x))$ is odd function so second integral is 0.

and $\Rightarrow \cos(f(x))$ is even function

$$\therefore g(t) = 2\cos\left(\frac{\pi t}{4}\right)\int_0^{\pi/2} \cos(f(x))dx$$
$$= 2k\cos\left(\frac{\pi t}{4}\right)\left\{\int_0^{\pi/2} \cos(f(x))dx = k\right\}$$

Now,

$$g(0) = 2k\cos 0 = 2k$$
$$g(1) = 2k\cos\left(\frac{\pi}{4}\right) = 2k\left(\frac{1}{\sqrt{2}}\right)$$

$$\therefore \quad \sqrt{2}g(1) = g(0)$$

Hence, the correct option is (2).

Q. 20 The area of the region, enclosed by the circle $x^2 + y^2 = 2$ which is not common to the region bounded by the parabola $y^2 = x$ and the straight line $y = x$, is

Option 1:
$\frac{1}{3}(12\pi - 1)$

Option 2:
$\frac{1}{6}(12\pi - 1)$

Option 3:
$\frac{1}{3}(6\pi - 1)$

Option 4:
$\frac{1}{6}(24\pi - 1)$

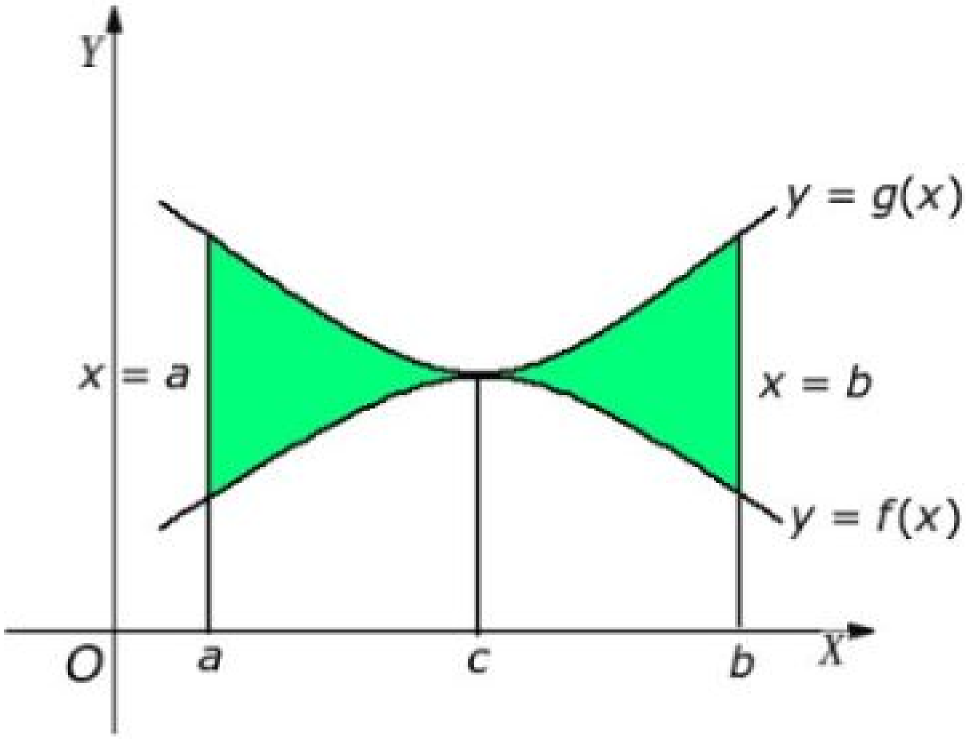
Correct Answer:
$\frac{1}{6}(12\pi - 1)$

Solution:

Area Bounded by Curves When Intersects at More Than One Po

Area bounded by the curves $y = f(x)$, $y = g(x)$ and intersect

First nd the point of intersection of these curves $y = f(x)$ an
c



Area of the shaded region

$$= \int_a^c \{f(x) - g(x)\}dx + \int_c^b \{g(x) - f(x)\}dx$$

When two curves intersects more than one point

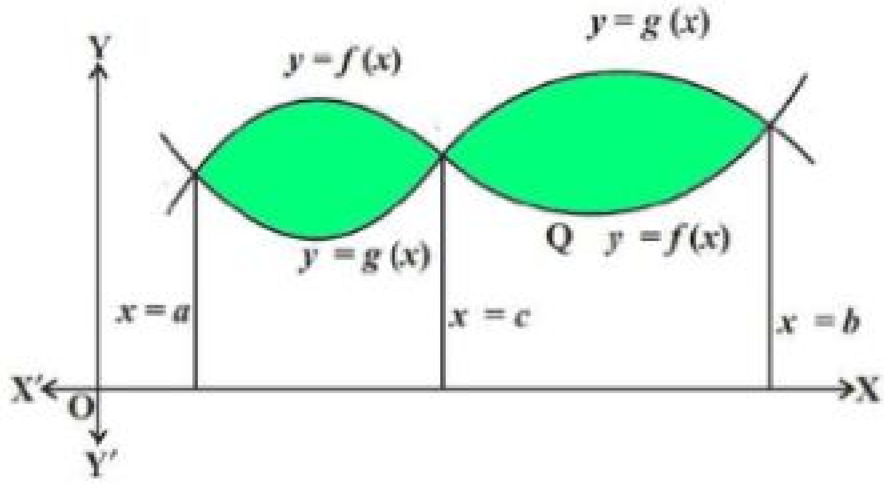
rea bounded by $y=f(x)$, $y=g(x)$ curves intersect each other $x=a$, $x=b$ and $x=c$ the point
c.

To nd the point of intersection, solve $f(x) = g(x)$.

For $x \in (a, c)$, $f(x) > g(x)$ and for $x \in (c, b)$, $g(x) > f(x)$.

Area bounded by curves,

$$\begin{aligned} \mathrm{A} &= \int_a^b |f(x) - g(x)|\, dx \\ &= \int_a^c (f(x) - g(x))\, dx + \int_c^b (g(x) - f(x))\, dx \end{aligned}$$



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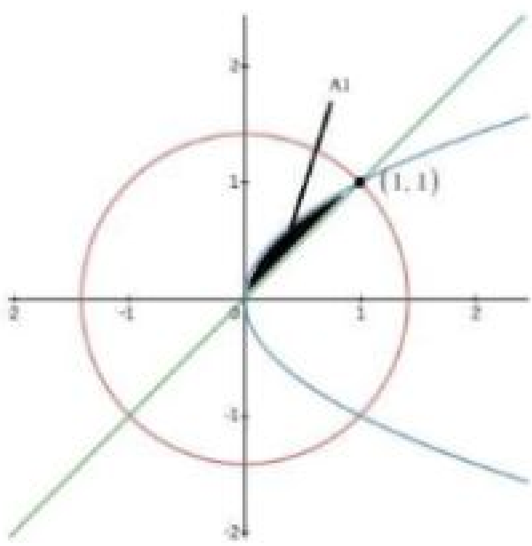
$x^2 + y^2 = 2 \Rightarrow r = \sqrt{2}$
$y^2 = x$
$y = x$



Area between parabola and line is A1

$$A1 = \int_0^1 (y^2 - y)dx$$
$$A1 = \int_0^1 (\sqrt{x} - x)dx = 1/6$$
Required area $= 2\pi - 1/6$

Correct Option (2)

Q. 21 If the area (in sq. units) of the region $\{(x, y): y^2 \leq 4x, x + y \leq 1, x \geq 0, y \geq 0\}$ is $a\sqrt{2} + b$ then $a - b$ is equal to :

Option 1:
$-\frac{2}{3}$

Option 2:

$\frac{10}{3}$

Option 3:

6

Option 4:

$\frac{8}{3}$

Correct Answer:

6

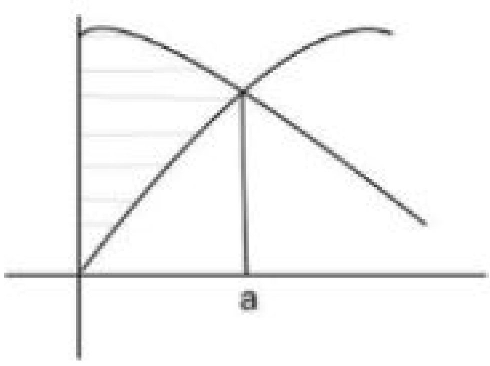
Solution:

Area between two curves -

If we have two functions intersection each other.First nd the area

$$\int_{o}^{a}\left[f\left(x\right)-9\left(x\right)\right]dx$$

- wherein



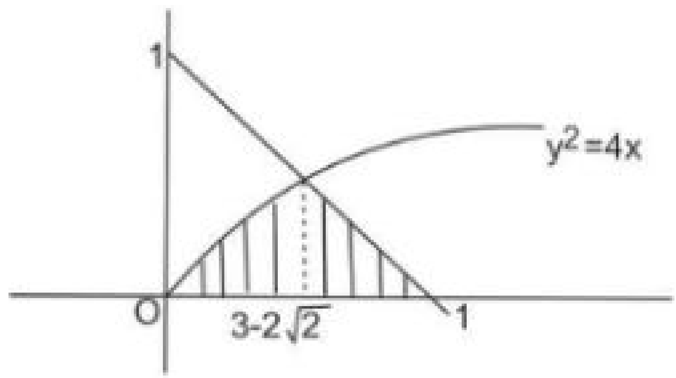
Inde nite integrals for Algebraic functions -

$$\frac{\mathrm{d}}{\mathrm{d}x}\frac{\left(x^{n+1}\right)}{n+1}=x^{n}\ \text{so}\ \int x^{n}dx=\frac{x^{n+1}}{n+1}+c$$

- wherein

Where $n\neq -1$

$$\left\{(x,y):y^{2}\leqslant 4x;x+y\leqslant 1,x\geqslant 0,y\geqslant 0\right\}$$



$$A=\int_0^{3-2\sqrt{2}} 2\sqrt{x}dx+\frac{1}{2}\left(1-\left(3-2\sqrt{2}\right)\right)\left(1-\left(3-2\sqrt{2}\right)\right)$$

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

$$=\frac{8\sqrt{2}}{3}+\left(-\frac{10}{3}\right)$$

$$a=\frac{8}{3}\ ,\ \ b=\frac{-10}{3}$$

$$a-b=\frac{8}{3}-\left(-\frac{10}{3}\right)=\frac{18}{3}=6$$

Q. 22 The area (in sq. units) of the region $y = 2^x$ and bounded by the cu

$y=|x+1|$, in the rst quadrant is :

Option 1:
$\log_e 2+\frac{3}{2}$

Option 2:
$\frac{3}{2}$

Option 3:
$\frac{1}{2}$

Option 4:
$\frac{3}{2}-\frac{1}{\log_e 2}$

Correct Answer:
$\frac{3}{2}-\frac{1}{\log_e 2}$

Solution:

Inde nite integrals for Exponential functions -

$$\frac{\mathrm{d}}{\mathrm{d}x}\left(e^{x}\right)=e^{x}$$

$$\int e^{x}\,dx=e^{x}+c$$

- wherein

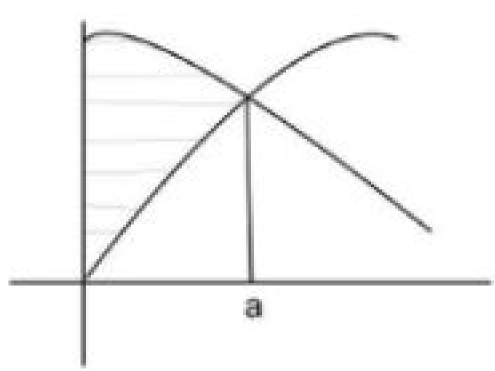
$$\because \int a^{x}dx=\frac{a^{x}}{log_{e}a}+c$$

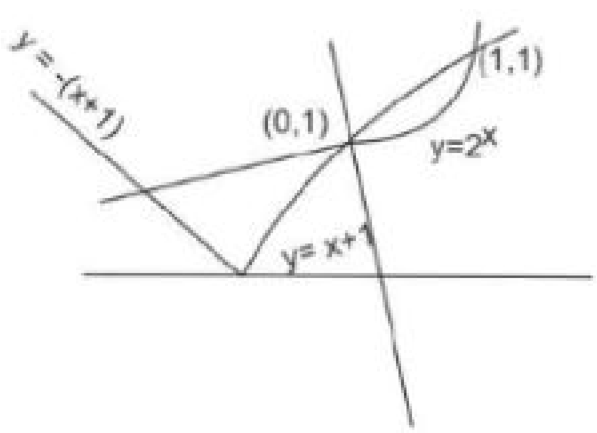
Area between two curves -

If we have two functions intersection each other.First nd the area

$$\int_{o}^{a}\left[f\left(x\right)-9\left(x\right)\right]dx$$

- wherein





$y = 2^x$ and $y = |x+1|$

The required area is

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

$$= [\frac{x^2}{2} + x - \frac{2^x}{\ln 2}]_0^1$$

$$= (\frac{1}{2} + 1 - \frac{2}{\ln 2}) - (0 + 0 - \frac{1}{\ln 2})$$

$$= \frac{3}{2} - \frac{1}{\ln 2}$$

So, option (4) is correct.

Q. 23 The difference between degree and order of a differential family of curves given by $y^2 = a\left(x + \frac{\sqrt{a}}{2}\right), a > 0$ is _______.

Correct Answer:
2

Solution:

$$y^2 = a\left(x + \frac{\sqrt{a}}{2}\right) = ax + \frac{a^{3/2}}{2}$$

differentiate both side

$$\Rightarrow 2yy' = a$$

$$\Rightarrow y^2 = (2yy')x + \frac{(2yy')^{3/2}}{2}$$

$$(y^2 - 2xyy') = \frac{(2yy')^{3/2}}{2}$$

squaring

$$(y^2 - 2xyy')^2 = \frac{y^3 (y')^3}{2}$$

Order = 1

Degree = 3

Q. 24 If $y = y(x)$ is the solution of the equation then $e^{\sin y} \cos y \frac{dy}{dx} + e^{\sin y} \cos x = \cos x, y(0) = 0; 1 + y\left(\frac{\pi}{6}\right) + \frac{\sqrt{3}}{2} y\left(\frac{\pi}{3}\right) + \frac{1}{\sqrt{2}} y\left(\frac{\pi}{4}\right)$ is equal to ________.

Correct Answer:

1

Solution:

$$\text{Put } e^{\sin y} = t$$
$$\Rightarrow e^{\sin y} \cos y \frac{dy}{dx} = \frac{dt}{dx}$$

Now, we have given equation is

$$e^{\sin y} \cos y \frac{dy}{dx} + e^{\sin y} \cos x = \cos x$$

$$\Rightarrow \text{D.E is } \frac{dt}{dx} + t \cos x = \cos x$$

$$\text{I.F.} = e^{\int \cos x dx} = e^{\sin x}$$
$$\Rightarrow \text{ solution is } t \cdot e^{\sin x} = \int \cos x e^{\sin x} dx$$
$$\Rightarrow e^{\sin y} e^{\sin x} = e^{\sin x} + c$$
$$\because x = 0, y = 0 \Rightarrow c = 0$$
$$\Rightarrow e^{\sin y} = 1$$
$$\Rightarrow y = 0$$

$$\Rightarrow 1 + y\left(\frac{\pi}{6}\right) + \frac{\sqrt{3}}{2} y\left(\frac{\pi}{3}\right) + \frac{1}{\sqrt{2}} y\left(\frac{\pi}{4}\right) = 1$$

Note that:

$$I = \int \cos x e^{\sin x} dx$$
$$\text{put } \sin x = u \Rightarrow \cos x dx = du$$
$$I = \int e^u du = e^u + C$$
$$I = e^{\sin x} + C$$

Q. 25 If a curve $y = f(x)$ passes through $(1, 2)$ then a point and it satisfies $x\frac{dy}{dx} + y = bx^4$, then for what value of b, $\int_1^2 f(x) dx = \frac{62}{5}$?

Option 1:
$\frac{31}{5}$

Option 2:
$\frac{62}{5}$

Option 3:
5

Option 4:
10

Correct Answer:
10

Solution:

$$\frac{dy}{dx}+\frac{y}{x}=bx^3$$
$\text{I.F.} = e^{\int\frac{1}{x}dx} = x$
So, solution of D.E. is given by
$$y\cdot x=\int b\cdot x^3\cdot x\,dx+c$$
$$y=\frac{c}{x}+\frac{bx^4}{5}$$
Passes through $(1,2)$
$$2=c+\frac{b}{5} \qquad \ldots(1)$$
$$\int_1^2 f(x)dx=\frac{62}{5}$$
$$\left[c\ln x+\frac{bx^5}{25}\right]_1^2=\frac{62}{5}$$
$$c\ln 2+\frac{31\,b}{25}=\frac{62}{5}$$
By equation (1) & (2)
$c=0$ and $b=10$

Q. 26 If $y=y(x)$ is the solution of the differential equation, $\frac{dy}{dx}+2y\tan x=\sin x$, $y\left(\frac{\pi}{3}\right)=0$, then the maximum value of the function $y(x)$ over R is equal to :

Option 1:
$-\frac{15}{4}$

Option 2:
$\frac{1}{2}$

Option 3:
$\frac{1}{8}$

Option 4:
8

Correct Answer:
$\frac{1}{8}$

Solution:

G i v e n   e q u a t i o n   i s   l i n e a r   d i   e r e n t i a l   e q u a t i o n

$$\frac{\mathrm{dy}}{\mathrm{dx}}+2\mathrm{y}\tan \mathrm{x}=\sin \mathrm{x}$$
$$\mathrm{I.F}\cdot=\mathrm{e}^{\int 2\tan \mathrm{xdx}}=\mathrm{e}^{2\ln \sec x}$$
$$\mathrm{I.F.}=\sec^2 \mathrm{x}$$
$$y\cdot\left(\sec^2 x\right)=\int \sin x\cdot\sec^2 x dx$$
$$y\cdot\left(\sec^2 x\right)=\int \sec x\tan x dx$$
$$y\cdot\left(\sec^2 x\right)=\sec x+C$$

N o w

$$\mathrm{x}=\frac{\pi}{3};\mathrm{y}=0$$
$$\Rightarrow \mathrm{C}=-2$$
$$\Rightarrow \quad y=\frac{\sec x-2}{\sec^2 x}=\cos x-2\cos^2 x$$
$$y=t-2t^2\Rightarrow\frac{dy}{dt}=1-4t=0\Rightarrow t=\frac{1}{4}$$
$$\therefore \quad \max=\frac{1}{4}-\frac{1}{8}=\frac{2-1}{8}=\frac{1}{8}$$

Q. 27 Let three vectors $\vec{a}, \vec{b}$ and $\vec{c}$ be such that $\vec{a} \times \vec{b} = \vec{c}$, $\vec{b} \times \vec{c} = \vec{a}$ and $|\vec{a}| = 2$. Then which one of the following is not true ?

Option 1:
$\vec{a} \times ((\vec{b} + \vec{c}) \times (\vec{b} - \vec{c})) = \vec{0}$

Option 2:
$Projection\ of\ \vec{a}\ on (\vec{b} \times \vec{c})\ is\ 2$

Option 3:
$\left[\begin{matrix} \vec{a} & \vec{b} & \vec{c} \end{matrix}\right] + \left[\begin{matrix} \vec{c} & \vec{a} & \vec{b} \end{matrix}\right] = 8$

Option 4:
$|3\vec{a} + \vec{b} - 2\vec{c}|^2 = 51$

Correct Answer:
$|3\vec{a} + \vec{b} - 2\vec{c}|^2 = 51$

Solution:
$\vec{a} \times \vec{b} = \vec{c} \Rightarrow \vec{c} \perp \vec{a}$ and $\vec{c} \perp \vec{b}$
$\vec{b} \times \vec{c} = \vec{a} \Rightarrow \vec{a} \perp \vec{b}$ and $\vec{a} \perp \vec{c}$
$\Rightarrow \vec{a}, \vec{b}, \vec{c}$ are mutually perpendicular $\Rightarrow \vec{a}$ is parallel to $\vec{b} \times \vec{c}$

(i) $\vec{a} \times ((\vec{b} + \vec{c}) \times (\vec{b} - \vec{c}))$

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

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

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

As $\vec{b} \times \vec{c}$ is parallel to $\vec{a} \Rightarrow \vec{a} \times (\vec{b} \times \vec{c}) = 0$

$= 0$

(ii) $Projection\ of\ \vec{a}\ on\ (\vec{b} \times \vec{c})$

$$= \frac{\vec{a} \cdot (\vec{b} \times \vec{c})}{|\vec{b} \times \vec{c}|} = \frac{|\vec{a}||\vec{b} \times \vec{c}| \cos 0^\circ}{|\vec{b} \times \vec{c}|} = 2$$

$(iii) \left[\begin{matrix} \vec{a} & \vec{b} & \vec{c} \end{matrix}\right] + \left[\begin{matrix} \vec{c} & \vec{a} & \vec{b} \end{matrix}\right]$

$= \left[\begin{matrix} \vec{a} & \vec{b} & \vec{c} \end{matrix}\right] + \left[\begin{matrix} \vec{a} & \vec{b} & \vec{c} \end{matrix}\right]$

$= 2\left[\begin{matrix} \vec{a} & \vec{b} & \vec{c} \end{matrix}\right]$

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

$= 2|\vec{a}||\vec{b} \times \vec{c}| \cos 0^\circ$

$= 4|\vec{b} \times \vec{c}|$

$= 4|\vec{b}||\vec{c}| \sin 90^\circ$

$= 4|\vec{b}||\vec{c}|$

Now $\vec{b} \times \vec{c} = \vec{a} \Rightarrow |\vec{b}||\vec{c}| \sin 90^\circ = |\vec{a}| \Rightarrow |\vec{b}||\vec{c}| = 2$

$2\left[\begin{array}{lll}\vec{a} & \vec{b} & \vec{c}\end{array}\right] = 8.$

Hence (iv) is false.

Q. 28 Let $\vec{a} = 2\hat{i} + \hat{j} - 2\hat{k}$ and $\vec{b} = \hat{i} + \hat{j}$. If $\vec{c}$ is a vector such that $\vec{a} \cdot \vec{c} = |\vec{c}|, |\vec{c} - \vec{a}| = 2\sqrt{2}$ and the angle between $(\vec{a} \times \vec{b})$ and $\vec{c}$ is $\frac{\pi}{6}$, then the value of $|(\vec{a} \times \vec{b}) \times \vec{c}|$ is :

Option 1:
$\frac{2}{3}$

Option 2:
4

Option 3:
3

Option 4:
$\frac{3}{2}$

Correct Answer:
$\frac{3}{2}$

Solution:
$|(\vec{a} \times \vec{b}) \times \vec{c}| = ||\vec{a} \times \vec{b}||\vec{c}| \cdot \sin\theta| = ||\vec{a} \times \vec{b}||\vec{c}\left| \cdot \sin\frac{\pi}{6}\right|$

Now ,

$$\vec{a} \times \vec{b} = \begin{vmatrix} i & j & k \\ 2 & 1 & -2 \\ 1 & 1 & 0 \end{vmatrix}$$
$$= i(2) - j(2) + k(1)$$
$$= 2i - 2j + k$$
$$|\vec{a} \times \vec{b}| = \sqrt{4+4+1} = 3 \qquad ----(ii)$$

Now we need to get $|\vec{c}|$

$$|\vec{c} - \vec{a}| = 2\sqrt{2}$$
$$\Rightarrow |\vec{c} - \vec{a}|^2 = (2\sqrt{2})^2$$
$$\Rightarrow (\vec{c} - \vec{a}) \cdot (\vec{c} - \vec{a}) = 8 \quad (\text{using } |\vec{a}|^2 = \vec{a} \cdot \vec{a})$$
$$\Rightarrow |\vec{c}|^2 - 2\vec{a} \cdot \vec{c} + |\vec{a}|^2 = b$$
$$\Rightarrow |\vec{c}|^2 - 2a \cdot c + 1a + 1 \Rightarrow |\vec{c}|^2 - 2|\vec{c}| + 9 = 8$$
$$(given\ \vec{a} \cdot \vec{c} = |\vec{c}|\ and\ for\ given\ \vec{a}, |\vec{a}| = 3)$$
$$\Rightarrow \quad |\vec{c}|^2 - 2|\vec{c}| + 1 = 0$$
$$\Rightarrow \quad (|\vec{c}| - 1)^2 = 0$$
$$\rightarrow |\vec{c}| = 1.$$

Using (1)

$$|(\vec{a} \times \vec{b}) \times \vec{c}| = |3 \cdot | \cdot \frac{1}{2} |= \frac{3}{2}$$

Q. 29 If $\vec{a} = \alpha\hat{i} + \beta\hat{j} + 3\hat{k}, \vec{b} = -\beta\hat{i} - \alpha\hat{j} - \hat{k}$ and $\vec{c} = \hat{i} - 2\hat{j} - \hat{k}$ such that $\vec{a}.\vec{b} = 1$ and $\vec{b}.\vec{c} = -3$, then $\frac{1}{3}\left(\left(\vec{a} \times \vec{b}\right).\vec{c}\right)$ is equal to __________.

Correct Answer:
2

Solution:

$$\vec{a} = \alpha\hat{i} + \beta\hat{j} + 3\hat{k},$$
$$\vec{b} = -\beta\hat{i} - \alpha\hat{j} - \hat{k} \text{ and}$$
$$\vec{c} = \hat{i} - 2\hat{j} - \hat{k}$$

$$\vec{a} \cdot \vec{b} = 1$$
$$\Rightarrow \qquad -\alpha\beta - \alpha\beta - 3 = 1$$
$$\Rightarrow \qquad -2\alpha\beta = 4 \Rightarrow \alpha\beta = -2 \qquad \ldots(1)$$

$\overrightarrow{b} \cdot \overrightarrow{c} = -3$

$\Rightarrow -\beta + 2\alpha + 1 = -3$

$\beta - 2\alpha = 4 \qquad \ldots(2)$

Solving (1) & (2)

$(\alpha, \beta) = (-1, 2)$

$$\frac{1}{3}[\vec{a}\vec{b}\vec{c}] = \frac{1}{3}\begin{vmatrix} \alpha & \beta & 3 \\ -\beta & -\alpha & -1 \\ 1 & -2 & -1 \end{vmatrix}$$

$$= \frac{1}{3}\begin{vmatrix} -1 & 2 & 3 \\ -2 & 1 & -1 \\ 1 & -2 & -1 \end{vmatrix}$$

$$= \frac{1}{3}\begin{vmatrix} 0 & 0 & 2 \\ -2 & 1 & -1 \\ 1 & -2 & -1 \end{vmatrix}$$

$$= \frac{1}{3}[2(4-1)] = 2$$

Q. 30 Let $\vec{c}$ be a vector perpendicular to the vectors $\vec{a} = \hat{i} + \hat{j} - \hat{k}$ and $\vec{b} = \hat{i} + 2\hat{j} + \hat{k}$. If $\vec{c}.\left(\hat{i} + \hat{j} + 3\hat{k}\right) = 8$ then the value of $\vec{c}\cdot\left(\vec{a} \times \vec{b}\right)$ is equal to:

Correct Answer:

28

Solution:

$\overrightarrow{c} = \lambda(\overrightarrow{a} \times \overrightarrow{b})$

$$\overrightarrow{a} \times \overrightarrow{b} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & 1 & -1 \\ 1 & 2 & 1 \end{vmatrix}$$

$(\overrightarrow{a} \times \overrightarrow{b}) = 3\hat{i} - 2\hat{j} + \hat{k}$

$\overrightarrow{c} \cdot (\hat{i} + \hat{j} + 3\hat{k}) = \lambda(3\hat{i} - 2\hat{j} + \hat{k}) \cdot (\hat{i} + \hat{j} + 3\hat{k})$

$\Rightarrow \lambda(4) = 8 \Rightarrow \lambda = 2$

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

$\overrightarrow{c} \cdot (\overrightarrow{a} \times \overrightarrow{b}) = 2|\overrightarrow{a} \times \overrightarrow{b}|^2 = 28$

Q. 31 Let the plane passing through the point $(-1, 0, -2)$ and perpendicular to each of the planes $2x + y - z = 2$ and $x - y - z = 3$ be $ax + by + cz + 8 = 0$. Then the value of $A + B + C$ is equal to:

Option 1:
3

Option 2:
8

Option 3:
5

Option 4:
4

Correct Answer:
4

Solution:
Normal to required plane is equal to $\vec{n}_1 \times \vec{n}_2$

$$\vec{n} = \begin{vmatrix} i & j & k \\ 2 & 1 & -1 \\ 1 & -1 & -1 \end{vmatrix} = -2i + j - 3k$$

Equation of plane is

$$-2(x+1) + 1(y-0) - 3(z+2) = 0$$
$$\Rightarrow -2x - 2 + y - 3z - 6 = 0$$
$$\Rightarrow -2x + y - 3z - 8 = 0$$
$$\Rightarrow 2x - y + 3z + 8 = 0$$
$$\therefore a = 2, b = -1, \quad z = 3$$
$$\therefore a + b + c = 4$$

Hence option (4) is correct answer

Q. 32 Let L be the line of intersection of planes $\vec{r} \cdot (\hat{i} - \hat{j} + 2\hat{k}) = 2$ and $\vec{r} \cdot (2\hat{i} + \hat{j} - \hat{k}) = 2$. If $P(\alpha, \beta, \gamma)$ is the foot of perpendicular on L from the point $(1, 2, 0)$, then the value of $35(\alpha + \beta + \gamma)$ is equal to :

Option 1:
101

Option 2:
119

Option 3:
143

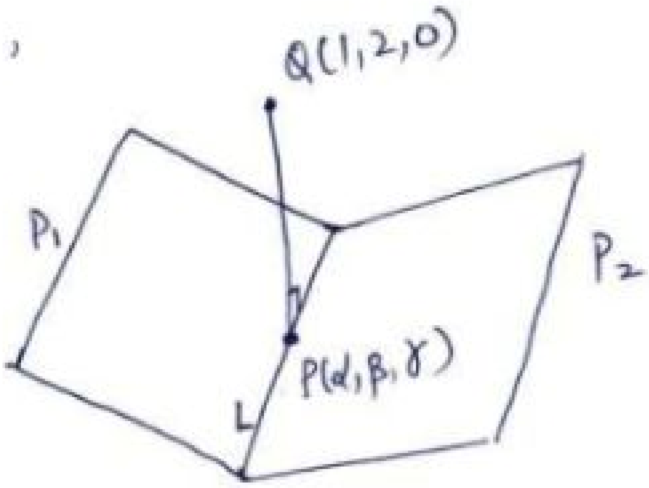
Option 4:
134

Correct Answer:
119

Solution:
Equation of planes are
$P_1: \quad x-y+2z-2=0$ with $\overrightarrow{n_1}=i-j^0+2k$.

$P_2: \quad 2x+y-z-2=0$ with $\vec{n}_2=2i+j-k$.

Let



P will lie on both planes.

$\alpha-\beta+2\gamma-2=0$ (i) and

$2\alpha+\beta-\gamma-2=0 \quad$ (ii)
Als $\overrightarrow{PQ}$ will be $\perp$ to line L.
$\Rightarrow \overrightarrow{PQ}$ will be $\perp$ to $\vec{n}_1\times\vec{n}_2$
$\Rightarrow \overrightarrow{PQ}\cdot(\vec{n}_1\times\overrightarrow{n_2})=0$
$\Rightarrow ((\alpha-1)i+(\beta-2)j+\gamma k)\cdot(-i+5j+3k)=0$
$\Rightarrow 1-\alpha+5\beta-10+3\gamma=0$
$\Rightarrow \quad \alpha-5\beta-3\gamma+9=0 \quad$ (iii)
Solving (i), (ii) and (iii)

$\alpha=\frac{99}{105},\beta=\frac{135}{105},\gamma=\frac{123}{105}$.

$35(\alpha+\beta+\gamma)=119$

Hence option (2) is correct.

Q. 33 The lines $x = ay - 1 = z - 2$ and $x = 3y - 2 = bz - 2, (ab \neq 0)$ are coplanar, if :

Option 1:
$b = 1, a \in R - \{0\}$

Option 2:
$\mathrm{a} = 1,\ \mathrm{b} \in \mathrm{R} - \{0\}$

Option 3:
$a = 2, b = 2$

Option 4:
$\mathrm{a} = 2,\ \mathrm{b} = 3$

Correct Answer:
$b = 1, a \in R - \{0\}$

Solution:
Lines can be re-written as

$$\frac{x}{1} = \frac{y - \frac{1}{a}}{\frac{1}{a}} = \frac{z-2}{1} \text{ and}$$
$$\frac{x}{1} = \frac{y - \frac{2}{3}}{\frac{1}{3}} = \frac{z - \frac{2}{b}}{\frac{1}{b}}$$

Line 1: $\vec{a_1} = \frac{1}{a}j + 2k, \quad \vec{b}_1 = i + \frac{1}{a}j + k$.

($\vec{a_1}$ is position vector of point lying on it and $\vec{b}_1$ is vector parallel to this line).

Line 2: $\vec{a}_2 = \frac{2}{3}j + \frac{2}{b}k$ and $\vec{b}_2 = i + \frac{1}{3}j + \frac{1}{b}k$.

Now lines are coplanar if $\left[\vec{a}_2 - \vec{a}_1 \ \vec{b}_1 \ \vec{b}_2\right] = 0$

$$\Rightarrow \begin{vmatrix} 0 & \frac{2}{3} - \frac{1}{a} & \frac{2}{b} - 2 \\ 1 & \frac{1}{a} & 1 \\ 1 & \frac{1}{3} & \frac{1}{b} \end{vmatrix} = 0$$

Expanding along row 1.

$$\Rightarrow \left(\frac{1}{a}-\frac{2}{3}\right)\left(\frac{1}{b}-1\right)+\left(\frac{2}{b}-2\right)\left(\frac{1}{3}-\frac{1}{a}\right)=0$$

$$\Rightarrow \frac{1}{a}\left(1-\frac{1}{b}\right)=0$$

$$\Rightarrow b=1 \text{ and } a\neq 0.$$

Hence option (1) is correct.

Q. 34 If the equation of the plane passing through the line of $2x-7y+4z-3=0, 3x-5y+4z+11=0$ and the point $(-2,1,3)$ is $ax+by+cz-7=0$, then the value of $2a+b+c-7$ is ___________.

Correct Answer:
4

Solution:

Required plane is

$$P_1+\lambda P_2=(2+3\lambda)x-(7+5\lambda)y+(4+4\lambda)z-3+11\lambda=0;$$

which is satis ed by the point (-2,1,3).

Hence $\lambda=\frac{1}{6}$

Thus, plane $15x-47y+28z-7=0$

So $2a+b+c-7=4$

Q. 35 Two dices are rolled. If both dices have six faces numbe
probability that the sum of the numbers on the top face

Option 1:
$\frac{4}{9}$

Option 2:
$\frac{1}{2}$

Option 3:
$\frac{5}{12}$

Option 4:
$\frac{17}{36}$

Correct Answer:
$\frac{5}{12}$

Solution:

Dice I : 1 and Dice II : 1,2,3,5,7

Dice I : 2 and Dice II : 1,2,3,5

Dice I : 3 and Dice II : 1,2,3,5

Dice I : 5 and Dice II : 1,2,3

Dice I : 7 and Dice II : 1

$n(E) = 5 + 4 + 4 + 3 + 1 = 17$

So, $P(E) = \frac{17}{36}$

Q. 36 A fair coin is tossed a xed number of times. If the prob
probability of getting 9 heads, then the probability of g

Option 1:
$\frac{15}{2^8}$

Option 2:
$\frac{15}{2^{13}}$

Option 3:
$\frac{15}{2^{14}}$

Option 4:
$\frac{15}{2^{12}}$

Correct Answer:
$\frac{15}{2^{13}}$

Solution:

Let the coin tossed n times

$$P(H)=P(T)=\frac{1}{2}$$

$$P(7 \text{ heads }) = {}^{n}C_{7}\left(\frac{1}{2}\right)^{n-7}\left(\frac{1}{2}\right)^{7}=\frac{{}^{n}C_{7}}{2^{n}}$$

$$P(9 \text{ heads }) = {}^{n}C_{9}\left(\frac{1}{2}\right)^{n-9}\left(\frac{1}{2}\right)^{9}=\frac{{}^{n}C_{9}}{2^{n}}$$

Given that

P(7 Heads) = P(9 Heads)

$${}^{n}C_{7}={}^{n}C_{9}\Rightarrow n=16$$

$$P(2 \text{ heads }) = {}^{16}C_{2}\left(\frac{1}{2}\right)^{14}\left(\frac{1}{2}\right)^{2}=\frac{15\times 8}{2^{16}}$$

$$P(2 \text{ heads }) = \frac{15}{2^{13}}$$

Q. 37 The probability of a man $\frac{1}{10}$ [illegible] sof shots requ
the probability of his hitting the target at least once in

Correct Answer:
3

Solution:

$$\text{We have, } 1- \text{ (probability of all shots result in failure) } >\frac{1}{4}$$

$$\Rightarrow 1-\left(\frac{9}{10}\right)^{n}>\frac{1}{4}$$

$$\Rightarrow \frac{3}{4}>\left(\frac{9}{10}\right)^{n}\Rightarrow n\geq 3$$

Q. 38 There are two urns. There are m white & n black balls in
balls in the second urn. One ball is taken from the rst
the probability of drawing a white ball from the second

Option 1:

$$\frac{pm+(p+1)n}{(m+n)(p+q+1)}$$

Option 2:

$$\frac{(p+1)m+pn}{(m+n)(p+q+1)}$$

Option 3:

$$\frac{qm+(q+1)n}{(m+n)(p+q+1)}$$

Option 4:

$$\frac{(q+1)m+qn}{(m+n)(p+q+1)}$$

Correct Answer:

$$\frac{(p+1)m+pn}{(m+n)(p+q+1)}$$

Solution:

Conditional Probability -

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

and

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

- wherein

where $P\left(\frac{A}{B}\right)$ **probability of A when B already happened.**

Independent events -

If A and B are independent events then probability of occurrence of A is not affected by occurrence or non occurrence of event B.

$$\therefore P\left(\frac{A}{B}\right)=P\left(A\right)$$

and $\therefore P\left(A\cap B\right)=P\left(B\right)\cdot P\left(\frac{A}{B}\right)$

so $\therefore P\left(A\cap B\right)=P\left(A\right)\cdot P\left(B\right)=P\left(AB\right)$

-

A ball from first urn can be drawn is two mannars

ball is white or ball is black

$p(w)=m/(m+n) \qquad p(B)=n/(m+n)$

Let E $\longrightarrow$ selecting a white ball from second urn after a ball from urn first has been placed into it

$$P(E)=P(w)P(E/W)+P(B)P(E/B)$$

$$=\frac{m}{m+n}\times\frac{p+1}{p+q+1}+\frac{n}{m+n}\frac{p}{p+q+1}$$

$$\frac{(p+1)m+pn}{(m+n)(p+q+1)}$$

Q. 39 Solution of differential equation $xdy/dx+y=xy\cos x$ is

Option 1:
$ln(xy)+\cos x=C$

Option 2:
$ln(xy)+\sin x=C$

Option 3:
$ln(xy)-\cos x=C$

Option 4:
$ln(xy)=\sin x+C$

Correct Answer:
$ln(xy)=\sin x+C$

Solution:

As we have learned

General form of Variable Separation -

$$d\left(logxy\right)=\frac{ydx+xdy}{xy}$$

-

Given equation can be written as xdy + y dx = xy cosx

on dividing both sides by xy , we get

$$\frac{xdy+ydx}{xy}=\cos x dx$$

$$\Rightarrow d(lnxy)=\cos x dx$$

on integrating , it gives

$$ln(xy)= \ sinx+C$$

Q. 40 Evaluate $\int_0^{\pi/2}\frac{e^{\sin x}}{e^{\sin x}+e^{\cos x}}dx$

Option 1:
π

Option 2:
π/ 4

Option 3:
π/ 2

Option 4:
π/ 8

Correct Answer:
π/ 4

Solution:
As we learnt

Properties of De nite Integration -

$$\int_0^a f(x)dx=\int_0^a f(a-x)dx$$

$$Thus \int_0^a \frac{f(x)}{f(x)+f(a-x)}dx = \frac{a}{2}$$

-

$$I = f(x) = \int_0^{\pi/2} \frac{e^{sinx}}{e^{sinx}+e^{cosx}}dx$$

$$I = f(\pi/2 - x) = \int_0^{\pi/2} \frac{e^{cosx}}{e^{sinx}+e^{cosx}}dx$$

Thus

$$2I = f(\pi/2 - x) = \int_0^{\pi/2} dx \Rightarrow I = \pi/4$$