JEE-Main-20-07-2021-Shift-1 (Memory Based)

PHYSICS

Question: A butterfly in North East direction with a velocity of $4\sqrt{2}m/s$. Wind is blowing from North to South with a velocity of 1 m/s. Find the displacement of the bird in three seconds.

Options:

(a) 15 m, $37°$ North to East

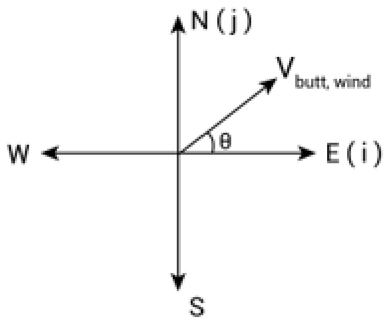
(b) 15 m, $37°$ East to North

(c) 15 m, $37°$ North to West

(d) None of these

Answer: (a)

Solution:



$\vec{V}_{butt} = 4m/s\hat{i} + 4m/s\hat{j}$

$\vec{V}_{wind} = -1m/s\hat{j}$

$\vec{V}_{butt,wind} = 4m/s\hat{i} + 3m/s\hat{j}$

Displacement of bird in three second.

$D = \sqrt{(4\times3)^2 + (3\times3)^2}$

$D = 15m$

Direction $\theta = \tan^{-1}\left(\frac{3}{4}\right)$

$\theta = 37°$

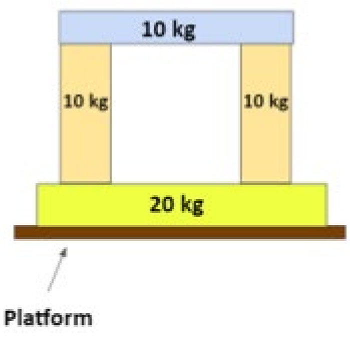
$\therefore$ 15m, $37°$ North to East.

Question: A travelling wave moving with a velocity v. The equation of wave at two different instants t = 0 and t = 3 is given by $y = \frac{1}{1+x^2}$ and $y = \frac{1}{1+(x+1)^2}$ respectively. Find the speed v of the wave. (y is in mm, x is in cm)

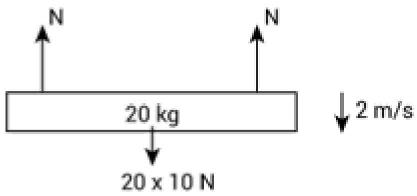
Options:

(a) $\frac{1}{3} mm/s$
(b) 3 mm/s
(c) $\frac{1}{3} cm/s$
(d) 3 cm/s
Answer: (c)
Solution:
$$y(x,0)=\frac{1}{1+x^2}$$
$$y(x,3)=\frac{1}{1+(x+1)^2}$$
If v is the velocity of the wave, then,
$$y(x,t)=y(x+vt,0)$$
Therefore,
$$y(x,3)=(x+3v,0)$$
Replacing values we get
$$\frac{1}{1+(x+1)^2}=\frac{1}{1+(x+3v)^2}$$
$$x+1=x+3v$$
$$x=+\frac{1}{3} cm/s$$

Question: A block of mass 20 kg is placed on a horizontal platform and three blocks each with mass 10kg are arranged as given in figure below. If platform accelerated downward with acceleration $2m/s^2$, then the normal force between 10 kg and 20 kg block is-



Options:
(a) 100 N
(b) 150 N
(c) 120 N
(d) 140 N
Answer: (c)
Solution:



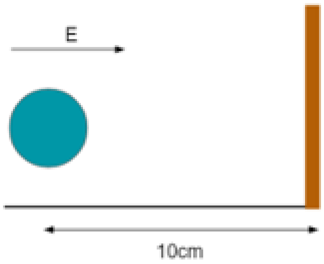
20 kg is rest w.r.t platform.

$2N = 200 + 20 \times 2$

$2N = 240N$

$N = 120N$

Question: A ball having charge to mass $8\mu c/g$ is placed at a distance of 10 cm from a wall. Suddenly an Electric field $100Nm^{-1}$ is switched on. Assuming collisions to be Elastic. Find Time period of oscillations.



Options:

(a) 0.5 sec

(b) 1 sec

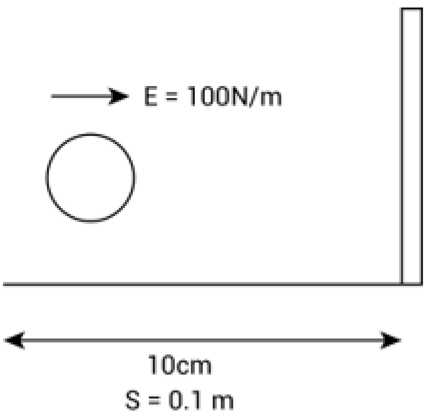
(c) $\sqrt{2}$ sec

(d) $\sqrt{3}$ sec

Answer: ()

Solution:

$\frac{q}{m} = 8\mu c/g$



$F = qE$

$$a = \frac{qE}{m}$$

$$a = \frac{8\times10^{-6}}{1\times10^{-3}}\times100$$

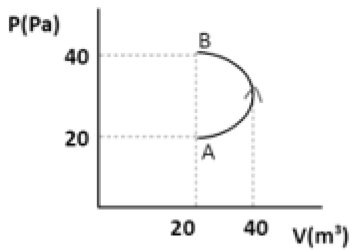
$$a = 0.8 m/s^2$$

Time period (T) $= 2\sqrt{\frac{2S}{a}}$

$$= 2\times\sqrt{\frac{2\times0.1}{8}}$$

T = 1 sec

Question: If an ideal gas is taken through process AB then find work done on gas by external agent. Given curve AB is an ellipse.



Options:

(a) $200\pi J$

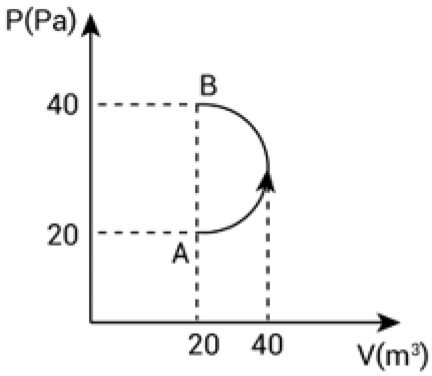
(b) $-200\pi J$

(c) $100\pi J$

(d) $-100\pi J$

Answer: (a)

Solution:



$$W_{external} + W_{gas} = 0$$

$$W_{external} = -W_{gas}$$

$$= -\left\{-\frac{\pi\times20\times20}{2}\right\}J$$

$$W_{external} = 200\pi J$$

Question: If $\vec{A}\cdot\vec{B}=\left|\vec{A}\times\vec{B}\right|$, find $\left|\vec{A}-\vec{B}\right|$

Options:

(a) $\sqrt{A^2+B^2+2A\cdot B}$

(b) $\sqrt{A^2+B^2+\sqrt{2}AB}$

(c) $\sqrt{A^2+B^2-\sqrt{2}AB}$

(d) $\sqrt{A^2+B^2}$

Answer: (c)

Solution:

$\vec{A}\cdot\vec{B}=\left|\vec{A}\times\vec{B}\right|$

$AB\cos\theta = AB\sin\theta$

$\cos\theta=\sin\theta$

$\Rightarrow \theta=\dfrac{\pi}{4}$

then

$\left|\vec{A}-\vec{B}\right|=\sqrt{A^2+B^2-2AB\cos 45^\circ}$

$\left|\vec{A}-\vec{B}\right|=\sqrt{A^2+B^2-\sqrt{2}AB}$

Question: Two charges are kept at a fixed distance from each other. The sum of both charges is Q. What should be charge on each of them in order to maximize force between them.

Options:

(a) $\dfrac{Q}{2},\dfrac{Q}{2}$

(b) $\dfrac{Q}{3},\dfrac{2Q}{3}$

(c) $\dfrac{2Q}{3},\dfrac{Q}{3}$

(d) $\dfrac{Q}{4},\dfrac{3Q}{4}$

Answer: (a)

Solution:

Let one charge be q_1 and other be $\theta-q_1$

$$F=K\frac{q_1\left(Q-q_1\right)}{r_2}$$

For maximum force $\dfrac{dF}{dq_1}=0$

and $\dfrac{d^2F}{dq_1^2}<0$

$$\frac{dF}{dq_1} = \frac{K(Q-q_1)}{r^2} - \frac{Kq_1}{r^2}$$

$$\frac{dF}{dq_1} = 0$$

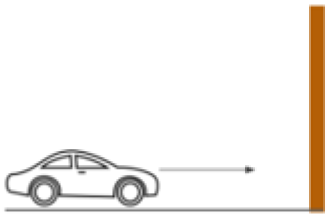
$$Q - q_1 - q_1 = 0 \Rightarrow q_1 = \frac{Q}{2}$$

$$\frac{d^2F}{dq_1^2} = -\frac{K}{r^2} - \frac{K}{r^2} = \frac{-2K}{r^2}$$

$-\frac{2K}{r^2} < 0$ for all values of q_1

So the value of $q_1 = \frac{Q}{2}$ and $Q - q_1 = \frac{Q}{2}$

Question: A car is moving towards a stationary wall making Horn of frequency 400 Hz. The Reflected frequency heard by driver of car is 500 Hz. Find speed of car [v = speed of sound]



Options:

(a) $\frac{V}{3}$

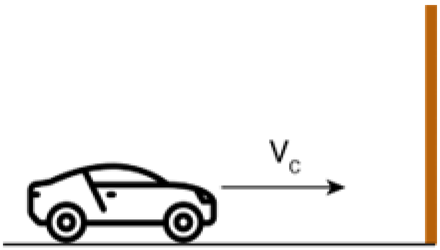
(b) $\frac{V}{4}$

(c) $\frac{V}{9}$

(d) $\frac{V}{12}$

Answer: (c)

Solution:



f' be the frequency heard at wall.

$$f' = \left(\frac{V_S}{V_S - V_C}\right) f \qquad \ldots(1)$$

Then this f' reflected back and the frequency heard by the driver is f''

$$f''=\left(\frac{V_S+V_C}{V_S}\right)f' \qquad \ldots(2)$$

From equation (1) and (2)

$$f''=\left(\frac{V_S+V_C}{V_S-V_C}\right)f$$

$$f''=\left(\frac{V+V_C}{V-V_C}\right)f$$

$$500=\left(\frac{V+V_C}{V-V_C}\right)\times 400$$

$$\frac{5}{4}=\frac{V+V_C}{V-V_C}$$

$$5V-5V_C=4V+4V_C$$

$$9V_C=V$$

$$V_C=\frac{V}{9}$$

Question: Light emitted by hydrogen gas corresponding to transition from n = 3 to n = 2 incident on a metal plate. The electron emitted from metal plate with maximum kinetic energy enters a magnetic field $5\times10^{-4}T$ perpendicularly. If the radius of path of electron is 7 mm then find the work function of metal.

Options:

(a) 0.91 eV

(b) 0.81 eV

(c) 0.01 eV

(d) 0.5 eV

Answer: (b)

Solution:

Energy of photon emitted by Hydrogen atom is

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

$$E=-13.6\left[\frac{1}{9}-\frac{1}{4}\right]$$

$$E=-13.6\frac{(-5)}{36}=\frac{13.6\times5}{36}\text{ eV} \qquad \ldots(1)$$

$$E=1.889\,\text{eV}$$

Now we have equation for kinetic energy

$$\left(\frac{1}{2}mv^2\right)_{\max}=hv-\phi$$

$$\ldots(2)$$

If radius of electron R

$$R = \frac{mv}{qB}$$

Squaring both side

$$R^2 = \frac{m^2v^2}{q^2B^2}$$

$$R^2 = \frac{2m(KE)}{q^2B^2}$$

$$KE = \frac{q^2B^2R^2}{2m}$$

$$KE = \frac{\left[1.6\times10^{19}\times5\times10^{-4}\times7\times10^{-3}\right]^2}{2\times9.1\times10^{-31}}$$

$$KE = \frac{3136\times10^{-52}}{2\times9.1\times10^{-31}}$$

$$KE = 172.30\times10^{-21}J$$

$$KE = 107.68\times10^{-2}\text{ eV}$$

$$KE = 1.077\text{ eV}$$

From eq (1),(2)and (3)

$$1.077 = 1.889 - \phi$$

$$\phi = 0.811\text{ eV} \sim 0.81\text{ eV}$$

Question: Consider on equation $S = \alpha^2\beta\ln\left[\frac{nkR}{J\beta^2}+1\right]$

Where S = Enkopy

n = No. of moles

k = Bolzmann constant

R = Universal Gas constant

J = Mechanical equivalent of Heat

Then Dimensions of $\propto$ and β respectively.

Options:

(a) $\left[M^0L^0T^0\right],\left[M^1L^2T^{-2}K^{-1}\right]$

(b) $\left[M^1L^2T^{-2}\right],\left[M^1L^2T^{-2}K^{-1}\right]$

(c) $\left[M^1L^2T^{-2}K^{-1}\right],\left[M^0L^0T^0\right]$

(d) None of these

Answer: (a)

Solution:

$$[S]=\left[ML^2T^{-2}K^{-1}\right]$$
$$n=[mol]$$
$$[k]=\left[ML^2T^{-2}K^{-1}\right]$$
$$[J]=\left[M^0L^0T^0\right]$$
$$[R]=\left[M^1L^2T^{-2}K^{-1}mol^{-1}\right]$$
$$S=\alpha^2\beta\ln\left[\frac{nkR}{J\beta^2}+1\right]$$
The quantity inside log must be dimensionless.
$$[nkR]=\left[J\beta^2\right]$$
$$[mol]\left[ML^2T^{-2}K^{-1}\right]\left[ML^2T^{-2}K^{-1}\right]\left[mol^{-1}\right]=[\beta]^2$$
$$\left[ML^2T^{-2}K^{-1}\right]^2=[\beta]^2$$
$$\beta=\left[ML^2T^{-2}K^{-1}\right]$$
Now
$$[S]=\left[\alpha^2\beta\right]$$
$$\left[ML^2T^{-2}K^{-1}\right]=\alpha^2\left[ML^2T^{-2}K^{-1}\right]$$
$$\alpha=\left[M^0L^0T^0K^0\right]$$

Question: An alpha particle and a deuteron enter a region of magnetic field which is perpendicular to their velocity. If their kinetic energies are equal, then find the ratio of their radii.

Options:

(a) $1:1$

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

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

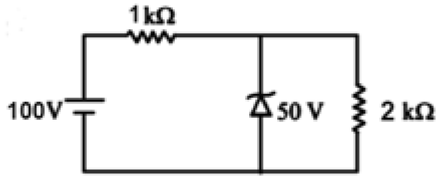
(d) $4:2$

Answer: (b)

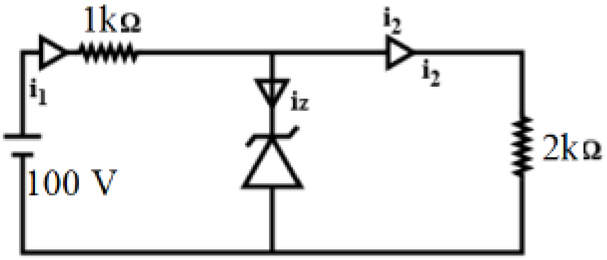
Solution:
$$\frac{mv^2}{R}=qvB$$
$$R=\frac{mv}{qB}=\frac{\sqrt{2mE}}{qB}$$
$$R_d=\frac{\sqrt{2m_dE}}{q_dB},R_\alpha=\frac{\sqrt{2m_\alpha E}}{q_\alpha B}$$

$$R_\alpha : R_d = \frac{\sqrt{m_\alpha}}{q_\alpha} : \frac{\sqrt{m_d}}{q_d} = \frac{\sqrt{4}}{2} : \frac{\sqrt{2}}{1} = 1 : \sqrt{2}$$

Question: A zener diode is used in a circuit as shown. Find the current 'I' passing through the zener diode.



Options:
(a) 25 mA
(b) 50 mA
(c) 100 mA
(d) zero
Answer: (a)
Solution:



For zener breakdown, potential difference across $2k\Omega$ resistor will be 5.0 V

$V_z = 50V$

$$i_2 = \frac{V_z}{2k} = \frac{50}{2k} = 25\ mA$$

ΔV across $1k\Omega = 100 - 50 = 50V$

$$i_1 = \frac{50}{1k} = 50\ mA$$

$i_1 = i_2 + i_z$

$i_z = 50\ mA - 25\ mA = 25\ mA$

Question: A current of 5 A is flowing through magnesium wire. The current density is making an angle of 60° with Area vector. Find the electric field. (Given : Area $=2m^{2}, \rho=$ Resistivity of Magnesium $=11\times10^{-4}$ SI units)

Options:

(a) $55\times10^{-4} V/m$

(b) $\frac{5}{11}\times10^{-4} V/m$

(c) $\frac{11}{5}\times10^{-4} V/m$

(d) $\frac{55}{2}\times10^{-4} V/m$

Answer: (a)

Solution:

$$E=J\rho$$
$$=\frac{I}{A\cos\theta}\rho$$
$$=\frac{5}{2\cos 60}\times11\times10^{-4}$$
$$=55\times10^{-4} V/m$$

Question: A body of mass emits a photon of frequency 'v', then loss in its internal energy is

Options:

(a) $h\nu$

(b) $h\nu\left(1-\frac{h\nu}{2mc^{2}}\right)$

(c) $h\nu\left(1+\frac{h\nu}{2mc^{2}}\right)$

(d) zero

Answer: (c)

Solution:

K.E. of body $=\left(\frac{1}{2}\right)mv^{2}=\left(\frac{1}{2}\right)m\left(\frac{E}{m}c\right)^{2}=\frac{E^{2}}{2mc^{2}}$

Energy emitted by photon = E

Total decrease in internal energy $=E+\frac{E^{2}}{2mc^{2}}$

$$=E\left(1+\frac{E}{2mc^{2}}\right)$$
$$=h\nu\left(1+\frac{h\nu}{2mc^{2}}\right) \quad (as E=h\nu)$$

Question: Tension in a spring is T_1 when length of the spring is L_1 and tension is T_2 when its length is L_2. The natural length of the spring is

Options:

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

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

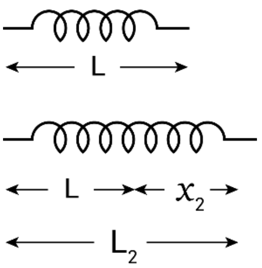
(c) $\frac{T_2 l_1 + T_1 l_2}{T_2 + T_1}$

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

Answer: (a)

Solution:

Let natural length of spring be L then on extending it by x_1 new length becomes L_1



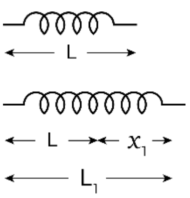
$$T_1 = Kx_1$$

$$K = \frac{T_1}{x_1} ...(1)$$

$$L_1 = L + x_1$$

$$x_1 = L_1 - L$$

On extending it by x_2 new length becomes L_2



$$T_2 = Kx_2$$

$$K = \frac{T_2}{x_2} ...(2)$$

$$L_2 = L + x_2 \Rightarrow x_2 = L_2 - L$$

Now spring constant remains same so from (1) and (2)

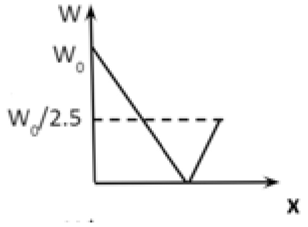
$$\frac{T_1}{x_1} = \frac{T_2}{x_2} \Rightarrow \frac{T_1}{L_1 - L} = \frac{T_2}{L_2 - L}$$

$$T_1\ L_2 - T_1 L = T_2 L_1 - T_2 L \Rightarrow L = \frac{T_2 L_2}{T_2 - T_1}$$

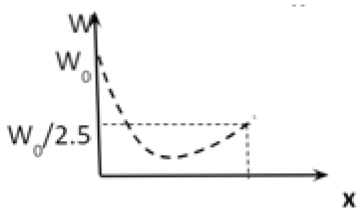
Question: A person is standing on weighing machine and is slowly taken from the surface of Earth to the surface of mars. Given that the value of g on Earth is $10 ms^{-2}$ and that on Mars is $4 ms^{-2}$. Draw graph of weight vs distance from earth's surface

Options:

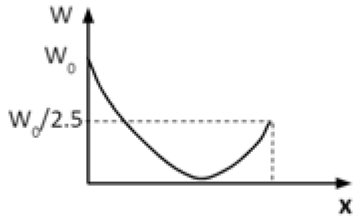
(a)



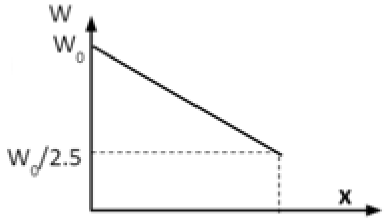
(b)



(c)



(d)



Answer: (c)

Solution:

$$g \propto \frac{1}{(\text{ distance})^2} \ldots(1)$$

Weight of the man goes from $W_o = m\,g$ on surface of earth to zero somewhere in the path (where gravitational

pull from both planets is equal to opposite) and finally to $\frac{W_o}{2.5}$ on surface of mass

g on earth = 10

g on mars $4 = \frac{10}{2.5} = \frac{g}{2.5}$

From (1) the decline from W_o to zero and rise from o to $W_o/4$ is non-linear
Hence (c) is the right answer.

Question: A chamber containing 4 moles of diatomic gas is heated such that the temperature of the gas increases from $0^\circ C$ to $50^\circ C$. Find the change in internal energy of the gas. Assume that molecules are rigid.

Options:

(a) 500 R

(b) 400 R

(c) 300 R

(d) 50 R

Answer: (a)

Solution:

Change in internal energy

$du = nC_v dT$

C_v for a diatomic gas is

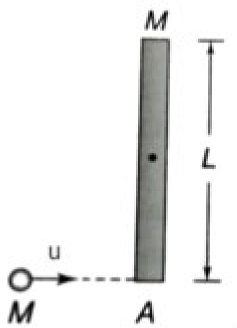
$\frac{5}{2}R$ ($\therefore$ temp given is not very high, so neglect vibrational degree of freedom)

Given $n = 4; C_v = \frac{5}{2}R$ and $dT = 50$

$\therefore du = 4(5/2R)(50)$

$= 500R$

Question: A particle of mass m and speed u collides elastically with the end of a uniform rod of mass M and length L as shown. If the particle comes to rest after collision, find $\frac{m}{M}$.



Options:

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

(b) 1

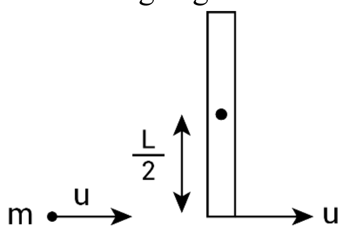
(c) $\frac{1}{3}$

(d) $\frac{1}{4}$

Answer: (a)

Solution:

Conserving angular momentum about the hinge at the center



$\vec{L}$ before collision $= mu(L/2)$

$\vec{L}$ after collision $= I\omega$

$$\omega = \frac{u}{(L/2)}$$

$$\therefore \text{mu}\left(\frac{L}{2}\right) = \frac{ML^2}{12}\left(\frac{u}{L/2}\right)$$

$$\frac{mu}{2} = \frac{Mu}{6}$$

$$\therefore \frac{m}{m} = \frac{1}{3}$$

Question: A radioactive material is undergoing simultaneous disintegration into two different products with half lives 1400 years and 700 years respectively. Find the time taken by the sample to decay to one third of its initial value

Options:

(a) $\left(\frac{\ln 2}{\ln 3}, \frac{1400}{3}\right)$ years

(b) $\frac{\ln 3}{\ln 2}(1400)$ years

(c) $\frac{\ln 3}{\ln 2}\frac{1400}{3}$ years

(d) $\frac{\ln 3}{\ln 2}(700)$ years

Answer: (c)

Solution:

We know that the number of atoms left after half-lives is given by

$$N = N_0\left(\frac{1}{2}\right)^n$$

where n=no of half lives

Now decay constant

$$(\lambda) = \left(\frac{\ln 2}{T_{1/2}}\right)$$

For a material containing 2 radioactive substances effective disintegration constant (λ_{eff})

$\lambda_{eff} = \lambda_A + \lambda_B$ [A and B are the substances]

$$\Rightarrow \frac{\ln 2}{T_{eff}} - \frac{\ln 2}{T_{1/2A}} + \frac{\ln 2}{T_{1/2B}}$$

$$\Rightarrow \frac{1}{T_{eff}} = \frac{1}{T_{1/2A}} + \frac{1}{T_{1/2B}}$$

Here $T_{eff} =$ Effective or equivalent half-life of the material.

Given $T_{1/2A} = 1400$ yrs

& $T_{1/2B} = 700$ yrs

We get

$$\mathrm{T}_{eff} = \frac{1400 \times 700}{1400 + 700}$$

$$= \frac{1400}{3}\, yrs.$$

$\therefore$ no. of half-lives $(n) = \dfrac{t}{(1400/3)}$

where t is time required for material to become one-third.

Now, $N = N_o \left(\frac{1}{2}\right)^n$

$$\frac{N}{N_o} = \left(\frac{1}{2}\right)^{t/(1400/3)}$$

$$\Rightarrow \left(\frac{1}{3}\right) = \left(\frac{1}{2}\right)^{t/(1400/3)}$$

$$\Rightarrow 3 = 2^{3t/1400}$$

$$\Rightarrow \ln 3 = (3t/1400)\ln 2 \Rightarrow t = \frac{\ln 3}{\ln 2}\left(\frac{1400}{3}\right) yrs$$

JEE-Main-20-07-2021-Shift-1 (Memory Based)

CHEMISTRY

Question: 10000 kJ energy is needed per day and heat of combustion 2700 kJ/mol, then find the grams of glucose needed?
Options:
(a) 666.67
(b) 650.33
(c) 459.50
(d) 576.62
Answer: (a)

Solution:

2700 kJ of energy → 180 g of glucose

1 kJ of energy → $\frac{180}{2700}$ g of glucose

10000 kJ of energy → $\frac{180}{2700}$ x 10000 = 666.67 g

Question: The difference in energy between the 2nd and 3rd orbit of He^+ ion will be?

Options:
(a) 5.34 eV
(b) 2.01 eV
(c) 7.54 eV
(d) 9.24 eV
Answer: (c)

Solution: Energy in 2nd orbit $= -13.6\ \frac{z^2}{n^2} = -13.6\ \frac{2^2}{2^2} = -13.6$ eV

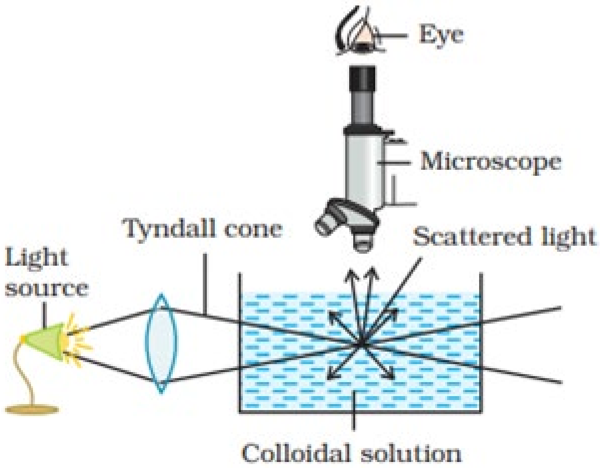
Energy in 3nd orbit $= -13.6\ \frac{z^2}{n^2} = -13.6\ \frac{2^2}{3^2} = -13.6 \text{ eV} \times \frac{4}{9} = -6.04$ eV

∴ Energy difference = $E_3 - E_2$ = 7.54 eV

Question: Tyndall effect conditions
Options:
(a) The diameter of the dispersed particles is much smaller than the wavelength of the light used
(b) The refractive indices of the dispersed phase and the dispersion medium are same in magnitude
(c) The radius of the dispersed particles is much smaller than the wavelength of the light used

(d) The refractive indices of the dispersed phase and the dispersion medium is not differ greatly in magnitude
Answer: (a)

Solution: Tyndall effect is observed only when the following two conditions are satisfied. (i) The diameter of the dispersed particles is not much smaller than the wavelength of the light used; and (ii) The refractive indices of the dispersed phase and the dispersion medium differ greatly in magnitude.



Question: Intensity of colour for $NiCl_4$, $Ni(H_2O)_4$, $Ni(CN)_4$
Options:
(a) $Ni(CN)_4 > Ni(H_2O)_4 > NiCl_4$
(b) $Ni(H_2O)_4 > NiCl_4 > Ni(CN)_4$
(c) $Ni(CN)_4 > NiCl_4 > Ni(H_2O)_4$
(d) $NiCl_4 > Ni(CN)_4 > Ni(H_2O)_4$
Answer: (a)

Solution: Order of intensity: $Ni(CN)_4 > Ni(H_2O)_4 > NiCl_4$

The intensity of colour depends on the strength of the ligand attached with the central metal atom. And strength of ligand is in the order:
$CN^- > H_2O > Cl^-$

Question: Azimuthal quantum number of valence electrons of Ga^{+1} is
(Atomic number of Ga = 31)
Options:
(a) $l = 0$
(b) $l = 1$
(c) $l = 2$
(d) $l = 3$
Answer: (a)

Solution:

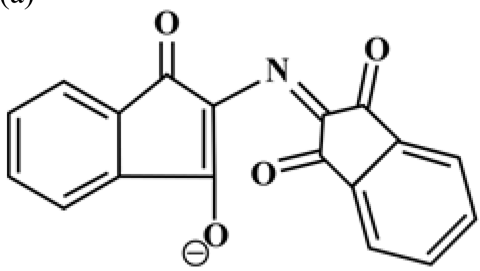
Ga: $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^1$

Ga: $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2$

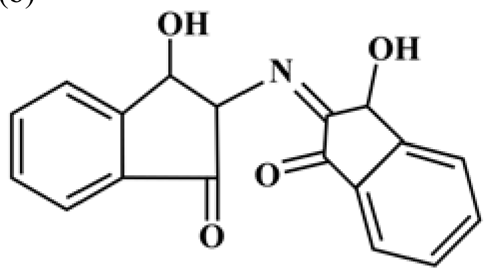
↓

$l = 0$

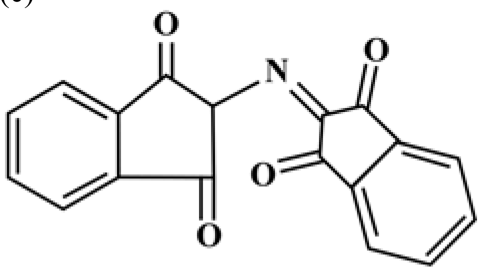
Question: Structure of ruhemann's purple from ninhydrin test
Options:
(a)



(b)

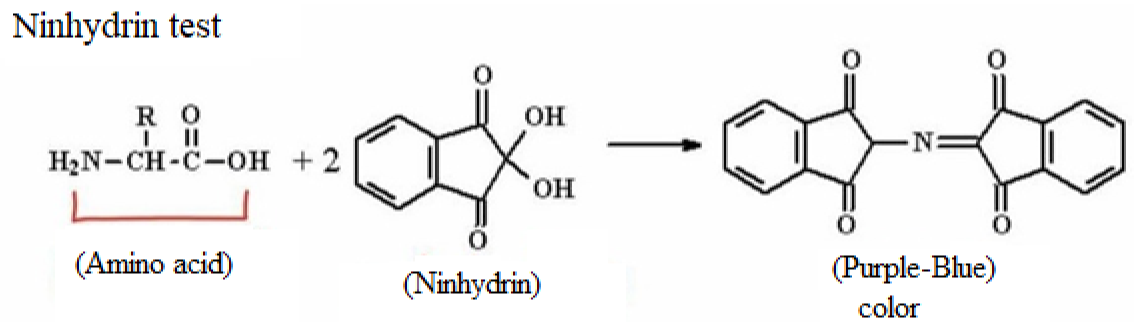


(c)



(d) Both (a) and (c)
Answer: (d)

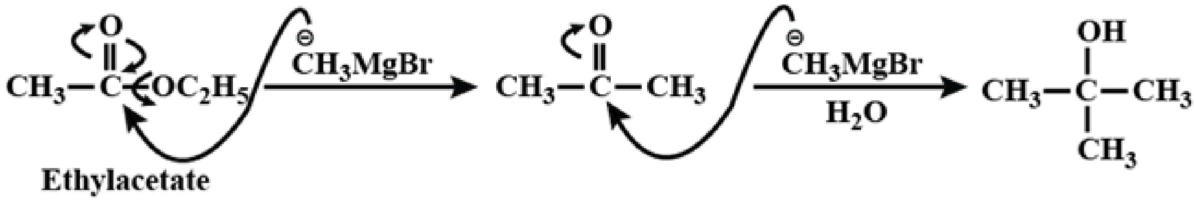
Solution:



Question: How many equivalents of CH_3MgBr to make 2-methylpropan-2-ol from ethyl ethanoate?
Options:

(a) 4
(b) 3
(c) 5
(d) 2
Answer: (d)

Solution:



Question: s-block element having formula of oxide MO_2, which is yellow and paramagnetic is

Options:
(a) Na
(b) K
(c) Ca
(d) Mg
Answer: (b)

Solution: KO_2 (yellowish colour) → $K^+ + O_2^-$ (paramagnetic)

Question: Which of the following can be purified using fractional distillation?
Options:
(a) Fe
(b) Cu
(c) Zn
(d) Ni
Answer: (c)

Solution: Extraction of zinc oxide

The reduction of zinc oxide is done using coke. The temperature in this case is higher than that in case of copper. For the purpose of heating, the oxide is made into briquettes with coke and clay.

$$ZnO + C \xrightarrow{\text{coke,1673K}} Zn + CO$$

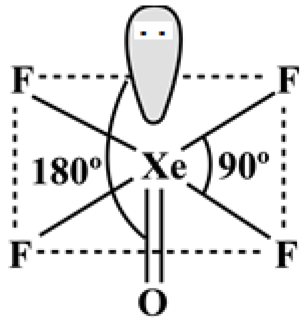
The metal is distilled off and collected by rapid chilling

Question: The hybridisation of Xenon in $XeOF_4$ is

Options:
(a) sp^3
(b) sp^3d

(c) sp^3d^2
(d) sp^3d^3
Answer: (c)

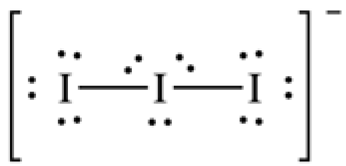
Solution:



Hybridisation of Xe in $XeOF_4$ is sp^3d^2

Question: Number of lone pairs on central atom in I_3^-
Options:
(a) 2
(b) 1
(c) 0
(d) 3
Answer: (d)

Solution:



Question: Which of these have different nature?
Options:
(a) $Be(OH)_2$ and $Al(OH)_3$
(b) $B(OH)_3$ and $Al(OH)_3$
(c) $B(OH)_3$ and H_3PO_3
(d) NaOH and $Ca(OH)_2$
Answer: (b)

Solution:

$Be(OH)_2$ & $Al(OH)_3$ are amphoteric.
$B(OH)_3$ & H_2PO_3 are acidic.
$Ca(OH)_2$ & NaOH are basic.

Question: Vapour pressure of benzene and methylbenzene are 70 and 20 respectively. Both are equimolar mixture. Find the mole fraction of benzene in vapour phase?
Options:
(a) 0.33
(b) 0.77
(c) 0.50
(d) 0.66
Answer: (b)

Solution: Gaseous phase

$X'_{Benzene} =?$

Liquid phase

$P_T = P_{Benzene}X_{benzene} + P_{methylbenzene}X_{methylbenzene}$

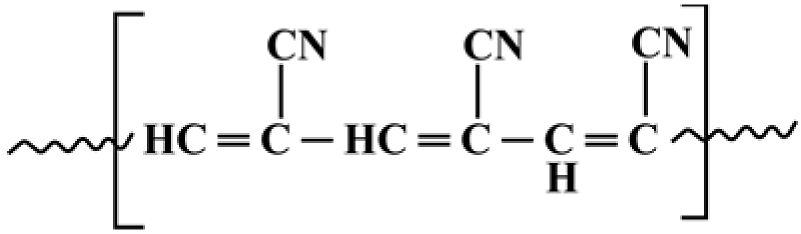
$= 70 \times ½ + 20 \times ½$

$= 35 + 10 = 45$

$X'_{Benzene} = \frac{35}{45} = 0.77$

Question: Orlon is
Options:
(a) polyamide
(b) polyester
(c) polyacrylonitrile
(d) Amino acid
Answer: (c)

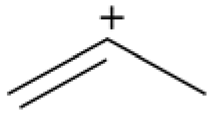
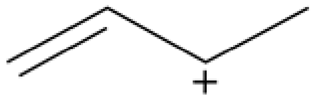
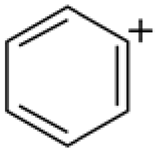
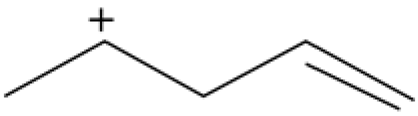
Solution:



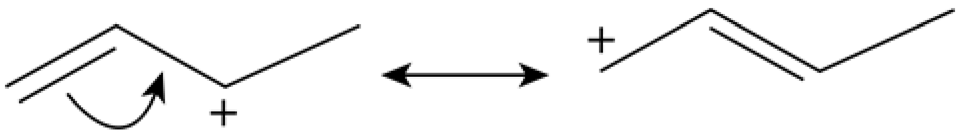
Orlon is the name that is used in trade purposes for Polyacrylonitrile (PAN). It is a polymer of acrylonitrile which is commonly known as vinyl cyanide (VCN)

Question: An example of green chemistry in daily life:
Options:
(a) CO_2 in cleaning clothes
(b) Cl_2 for bleaching
(c) Tetrafluoroethane in laundry
(d) All of these
Answer: (a)

Solution: While CO_2 is a main greenhouse gas, no new CO_2 is generated with this technology, so it does not contribute to global warming. Liquid CO_2 companies recapture the CO_2 that's already a by-product of several manufacturing processes, and they then recycle it into the liquid solvent for cleaning clothes. The main drawback is that, while the CO_2 itself is both cheap and abundant, the cost of a CO_2 dry cleaning machine is very high. Few dry cleaners are adopting this technique for this reason.

Question: Which of the following carbocation can show resonance?
Options:
(a)

(b)

(c)

(d)

Answer: (b)

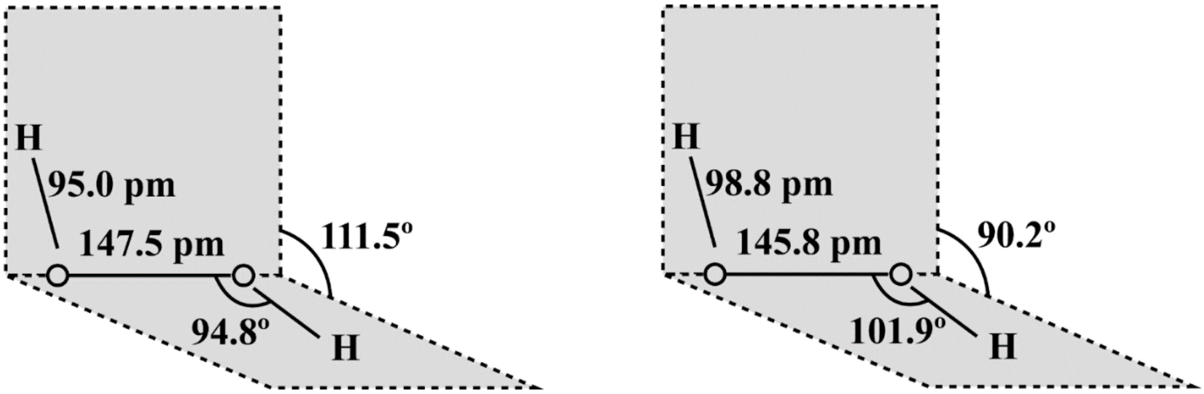
Solution:



Question: Assertion: In gas phase, the angle of H_2O_2 is 90.2° and in solid phase, it is 112°
Reason: It is due to intermolecular forces
Options:
(a) If both assertion and reason are true and the reason is the correct explanation of the assertion.
(b) If both assertion and reason are true but reason is not the correct explanation of the assertion.
(c) If assertion is true but reason is false.
(d) If assertion is false but reason is true.
Answer: (a)

Solution: Hydrogen peroxide has a non-planar structure. The molecular dimension in the gas phase and solid are shown in figure

In solid-state, there are stronger intermolecular forces. So, the angle is less.



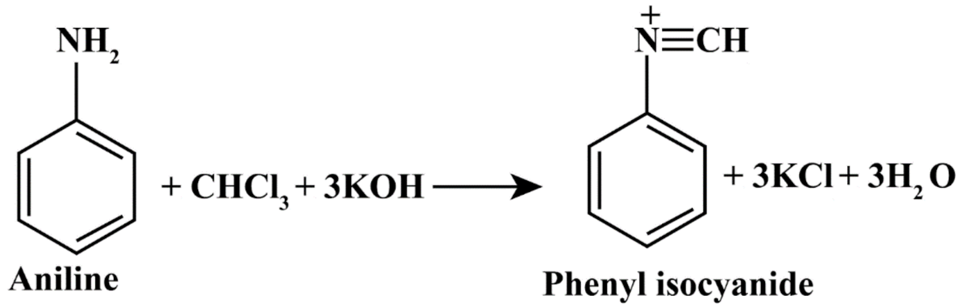
(a) H_2O_2 structures in gas phase, dihedral angle is 111.5°

(b) H_2O_2 structure in solid phase at 110 K, dihedral angle is 90.2°

Question: Organic compound A with $CHCl_3$/KOH gives product B which can be decomposed by H^+/H_2O?
Options:
(a) A = Primary amine, B = isonitrile
(b) A = Secondary amine, B = Primary amine
(c) A = isonitrile, B = Primary amine
(d) A = Carboxylic acid, B = Primary amine
Answer: (a)

Solution: Primary amine on reaction with $CHCl_3$ & KOH gives isocyanide or isonitrile.

$$\underset{\text{Ethyl Amine}}{CH_3CH_2NH_2} + \underset{\text{alcoholic}}{CHCl_3 + 3KOH} \longrightarrow \underset{\text{Ethyl isocyanide}}{CH_3CH_2NC} + 3KCl + 3H_2O$$



Question: Which of the following does not disproportionate?
Options:
(a) BrO^-
(b) BrO_2^-
(c) BrO_3^-
(d) BrO_4^-
Answer: (d)

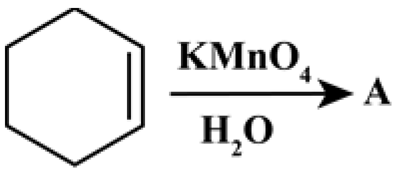
Solution: In BrO_4^- the oxidation state of Br is +7 is the maximum possible oxidation state of Br.

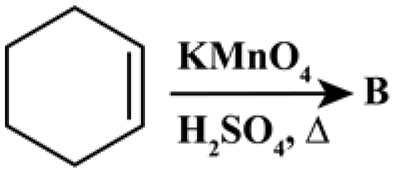
So, it can only undergo reduction.

Question: IF P_4P_{10} + HNO_3 are mixed in 1 : 4 ratio, then nature of nitrogen oxide obtained is
Options:
(a) Acidic
(b) Basic
(c) Amphoteric
(d) Neutral
Answer: (a)

Solution: The reaction as follows
$4HNO_3 + P_4O_{10} \rightarrow 2N_2O_5 + 4HPO_3$

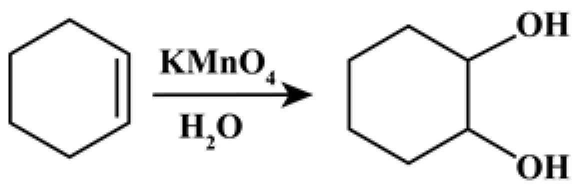
Question: Product A and B for the following reaction is



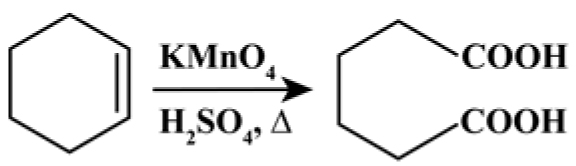


Options:
(a) A = Cyclohexane-1,6-diol, B = Hexan-1,6-dioic acid
(b) A = Cyclopentane-1,5-diol B = Pentan-1,5-dioic acid
(c) A = Benzene, B = Benzoic acid
(d) A = Phenol, B = Hexane
Answer: (a)

Solution:



(A)



(B)

Question: 250 ml 0.5 M NaOH, and 500 ml of 1 M HCl. Find the number of molecules of HCl remaining after reaction in the form of 10^{21}.
Answer: 225.82

Solution:

Base (NaOH)

n = 0.5 M × 250 ml

= 125 millimoles

= 0.125 moles

Acid (HCl)

N = 1 M × 500 ml

= 500 millimoles

= 0.5 moles

Remaining moles of HCl = 0.5 – 0.125 = 0.375 moles

1 mole ≡ N_A molecules

0.375 moles ≡ $N_A \times 0.375$ molecules = 225.825×10^{21} molecules

JEE-Main-20-07-2021-Shift-1 (Memory Based)

MATHEMATICS

Question: Tangent and normal are drawn to $y^2 = 2x$ at $A(2, 2)$. Tangent cuts x-axis at T and normal cuts parabola again at p. Find area of ΔATP.

Options:

(a) $\frac{25}{2}$

(b) 25

(c)

(d)

Answer: (a)

Solution:

Equation of tangent is $2y = x + 2$

And equation of normal is $2x + y = 6$

$\therefore T(-2,0)$ and $P\left(\frac{9}{2},-3\right)$

$\therefore$ Area = $\frac{1}{2}\begin{vmatrix} -2 & 0 & 1 \\ \frac{9}{2} & -3 & 1 \\ 2 & 2 & 1 \end{vmatrix}$

$= \frac{1}{2}[10+15] = \frac{25}{2}$

Question: Find the coefficient of x^{256} in $[1-x]^{101} \times \left(x^2+x+1\right)^{100}$

Options:

(a) ${}^{100}C_{15}$

(b) $-{}^{100}C_{15}$

(c) ${}^{100}C_{18}$

(d) $-{}^{100}C_{16}$

Answer: (a)

Solution:

$(1-x)^{101}\left(x^2+x+1\right)^{100}$

$=(1-x)\left[(1-x)\left(x^2+x+1\right)\right]^{100}$

$=(1-x)\left(1-x^3\right)^{100}$

For $\left(1-x^3\right)^{100}$

$T_{r+1}={}^{100}C_r\left(-x^3\right)^r$

For x^{256}, 1 will multiply with x^{256} and x will multiply with x^{255}.

x^{256} in $\left(1-x^3\right)^{100}$ is not possible

For $x^{255}, r=85$

$\therefore$ coefficient $=1\times 0+(-1)\times\left(-{}^{100}C_{85}\right)$

$={}^{100}C_{85}={}^{100}C_{15}$

Question: If the shortest distance between the lines
$\overline{r_1}=\alpha\hat{i}+2\hat{j}+2\hat{k}+\lambda\left(\hat{i}-2\hat{j}+2\hat{k}\right), \lambda\in R, \alpha>0$ and $\overline{r_2}=-4\hat{i}-\hat{k}+\mu\left(3\hat{i}-2\hat{j}-2\hat{k}\right), \mu\in R$ is 9, then α is equal to

Options:

(a)

(b)

(c)

(d)

Answer: 6

Solution:

$$\text{S.D.} = \frac{\begin{vmatrix}\alpha+4 & 2 & 3\\ 1 & -2 & 2\\ 3 & -2 & -2\end{vmatrix}}{\begin{vmatrix} i & j & k\\ 1 & -2 & 2\\ 3 & -2 & -2\end{vmatrix}}$$

$$=\frac{8(\alpha+4)+16+12}{\sqrt{64+64+16}}=9$$

$=8\alpha+60=108$

$\Rightarrow \alpha=6$

Question: $x^2 + 3^{\frac{1}{4}}x + \sqrt{3} = 0$ roots are α, β. Find $\alpha^{96}\left(\alpha^{12} - 1\right) + \beta^{96}\left(\beta^{12} - 1\right)$

Options:

(a) $3^{24}.52$

(b) $3^{24}.56$

(c) $3^{25}.52$

(d) $3^{25}.56$

Answer: (a)

Solution:

Let $a = 3^{\frac{1}{4}}$

$\therefore x^2 + ax + a^2 = 0$

$$x = \frac{-a \pm \sqrt{3}ai}{2}$$

$$\therefore \ \alpha = \frac{-a - i\sqrt{3}a}{2} = a\omega$$

$$\beta = \frac{-a + i\sqrt{3}a}{2} = a\omega^2$$

$\therefore \alpha^{96}\left(\alpha^{12} - 1\right) + \beta^{96}\left(\beta^{12} - 1\right) = 2a^{96}\left(a^{12} - 1\right) = 3^{24} \cdot 52$

Question: The word EXAMINATION is given : then the Probability that the M is at the 4th place is-

Options:

(a) $\frac{1}{11}$

(b) $\frac{9}{11}$

(c)

(d)

Answer: (a)

Solution:

Total case $= \dfrac{11!}{2! \cdot 2! \cdot 2!}$

Favourable case $= \dfrac{10!}{2! \cdot 2! \cdot 2!}$

$\therefore$ Required probability $= \dfrac{\dfrac{10!}{2!\cdot 2!\cdot 2!}}{\dfrac{11!}{2!\cdot 2!\cdot 2!}}$

$= \dfrac{1}{11}$

Question: $a_{ij} = \begin{cases} 1, & i = j \\ -x, & |i-j| = 1 \\ 2x+1, & \text{otherwise} \end{cases}$ $A = \left[a_{ij}\right]_{3\times 3}$. $f(x) = \det(A)$. Sum of maximum and minimum values of $f(x)$.

Options:

(a) $\dfrac{20}{27}$

(b) $\dfrac{-20}{27}$

(c) $\dfrac{88}{27}$

(d) $\dfrac{-88}{27}$

Answer: (a)

Solution:

$$A = \begin{bmatrix} 1 & -x & 2x+1 \\ -x & 1 & -x \\ 2x+1 & -x & 1 \end{bmatrix}$$

$|A| = 4x^3 - 4x^2 - 4x$

$f(x) = 4x^3 - 4x^2 - 4x$

$f'(x) = 12x^2 - 8x - 4$

$= 4(3x^2 - 2x - 1)$

$= 4(x-1)(3x+1)$

$f'(x) = 0$ gives $x = 1, \dfrac{-1}{3}$

$f(1) = -4$

$f\left(\frac{-1}{3}\right)=\frac{20}{27}$

Sum = $-4+\frac{20}{27}=\frac{-88}{27}$

Question: $\int_0^a e^{x-[x]}dx=10e-9$, find '$a$'.

Options:

(a) $10+\ln(1+e)$

(b) $10-\ln(1+e)$

(c) $10+\ln 2$

(d) $10+\ln 3$

Answer: (c)

Solution:

$$\int_0^a e^{x-[x]}\,dx=\int_0^{[a]} e^{\{x\}}\,dx+\int_{[a]}^a e^{\{x\}}\,dx$$

$$=[a]\int_0^1 e^x\,dx+\int_{[a]}^a e^{x-[a]}\,dx$$

$$=[a](e-1)+e^{-[a]}\left(a^a-2^{[a]}\right)$$

$$=[a]e+\left(-1-[a]-e^{a-[a]}\right)$$

$$=10e-9$$

On equality, $a=10+\ln 2$

Question: $|z.\omega|=1\arg(z)-\arg(\omega)=\frac{3\pi}{2}$ find $\arg\left[\frac{1-2\bar{z}\omega}{1+3\bar{z}\omega}\right]$

Options:

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

(b) $\frac{-\pi}{4}$

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

(d) $\frac{-3\pi}{4}$

Answer: (d)

Solution:

Let $\omega = re^{i\theta}$

$$\therefore\ z = \frac{1}{r}e^{i\left(\theta+\frac{3\pi}{2}\right)}$$

$$\therefore\ \bar{z}\omega = \left[\frac{1}{r}e^{-i\left(\theta+\frac{3\pi}{2}\right)}\right]\left[r\cdot ei\theta\right] = e - i\frac{3\pi}{2} = i$$

$$\Rightarrow \left(\frac{1-2i}{1+3i}\right)\left(\frac{1-3i}{1-3i}\right) = \frac{-5-5i}{10}$$

$$\Rightarrow \arg = \frac{-3\pi}{4}$$

Question: $f(x) = \begin{cases} a+[-x], & (0,1) \\ 2x-b, & [1,\infty) \\ x^2-1, & (-\infty, 0] \end{cases}$ Find $(a+b)$ if $f(x)$ is continuous on R.

Options:

(a) 2

(b) 3

(c) 4

(d) 5

Answer: (b)

Solution:

$$f(x) = \begin{cases} a+[-x], & (0,1) \\ 2x-b, & [1,\infty) \\ x^2-1, & (-\infty,0] \end{cases}$$

$$f(1^-) = f(1^+)$$

$$\Rightarrow \lim_{h\to 0} a + \left[-(1-h)\right] = \lim_{h\to 0} 2(1+h) - b$$

$$\Rightarrow a - 1 = 2 - b$$

$$\Rightarrow a + b = 3$$

Question: $\left(4^{\frac{1}{4}} + 5^{\frac{1}{6}}\right)^{120}$ total number of integral terms is _____.

Options:

(a)

(b) 11

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

For $\left(4^{\frac{1}{4}}+5^{\frac{1}{6}}\right)^{120}$

$T_r = {}^{120}C_r \cdot 4^{\frac{120-r}{4}} \cdot 5^{\frac{r}{6}}$

r is a multiple of 6 and 4

Hence multiple of 12

$r = 0, 12, 24, ...120$

Hence 11 integral terms

Question: From a team of 15 players, 6 are bowlers, 7 are batsman, 2 are wicket keepers. Find the number of ways to form a team of II players having atleast 4 bowlers 5 batsman, 1 wicket keeper.
Answer: 777
Solution:
Ways to form team of 11

5 Bowlers, 5 Batsman, 1 wicket keeper

${}^{6}C_5 \times {}^{7}C_5 \times {}^{2}C_1 = 252$
$6 \times 7 \times 6$

4 Bowlers, 6 Batsman, 1 wicket keeper

${}^{6}C_4 \times {}^{7}C_6 \times {}^{2}C_1 = 210$

4 Bowler, 5 Batsman, 2 wicket keeper

${}^{6}C_4 \times {}^{7}C_5 \times {}^{2}C_2 = 315$

Total number of ways = 252 + 210 + 315 = 777

Question: $\overline{a}, \overline{b}, \overline{c}$ are manually $\perp$ unit vector equally inclined to $\overline{a}+\overline{b}+\overline{c}$ at angle θ. Find $36\cos^2 2\theta$ ...
Answer: 4
Solution:

$$\cos\theta = \frac{\overline{a}\cdot\left(\overline{a}+\overline{b}+\overline{c}\right)}{|\overline{a}|\left|\overline{a}+\overline{b}+\overline{c}\right|} \qquad ....(1)$$

Also, $\left(a+\overline{b}+\overline{c}\right)^2 = 3+2\times 0$

$$\therefore \left|\overline{a}+\overline{b}+\overline{c}\right| = \sqrt{3} \qquad ....(2)$$

From (1) and (2)

$$\cos\theta = \frac{1}{\sqrt{3}} \Rightarrow \cos 2\theta = -\frac{1}{3}$$

$$36\cos^2 2\theta = \frac{36}{9} = 4$$

Question: Let a, b, c, d be in A.P with common difference λ. If

$$\begin{vmatrix} x+a-c & x+b & x+a \\ x-1 & x+c & x+b \\ x-b+d & x+d & x+c \end{vmatrix} = 2 \text{ then } \lambda^2 = ?$$

Answer: -1

Solution:

Put $x=0$

$$\begin{vmatrix} -2\lambda & a+\lambda & a \\ -1 & a+2\lambda & a+\lambda \\ 2\lambda & a+3\lambda & a+2\lambda \end{vmatrix} = 2$$

$$\Rightarrow \begin{vmatrix} -2\lambda & a+\lambda & a \\ 2\lambda-1 & \lambda & \lambda \\ 2\lambda+1 & \lambda & \lambda \end{vmatrix} = 2$$

$$\Rightarrow \begin{vmatrix} -2\lambda & a+\lambda & -\lambda \\ 2\lambda-1 & \lambda & 0 \\ 2\lambda+1 & \lambda & 0 \end{vmatrix} = 2$$

$$\Rightarrow -\lambda\left[\left(2\lambda^2-\lambda\right)-\left(2\lambda^2+\lambda\right)\right] = 2$$

$$\Rightarrow \lambda^2 = 1$$

Question: The probability of selecting integers $a \in (-5, 30]$, such that $x^2 + 2(a+4)x - 5a + 64 > 0$, for all $x \in R$, is:

Answer: $\frac{2}{9}$

Solution:

$\Delta < 0$

$4(a+4)^2 - 4(-5a+64) < 0$

$a^2 + 16 + 8a + 5a - 64 < 0$

$a^2 + 13a - 48 < 0$

$(a+16)(a-3) < 0$

$a \in (-16, 3)$

$\therefore$ Probability $= \frac{8}{36} = \frac{2}{9}$

Question: Let $y = mx + c,\ m > 0$ be the focal chord of $y^2 = -64x$ which is tangent to $(x+10)^2 + y^2 = 4$. Then the value of $4\sqrt{2}(m+c)$ is equal to _____.

Answer: 34

Solution:

Focus of $y^2 = -64x$ is $(-16, 0)$

Hence $y = mx + c$ passes through $(-16, 0)$

$\Rightarrow 0 = m(-16) + c$

$\Rightarrow c - 16m = 0$

$\Rightarrow c = 16m \quad ...(1)$

Centre of $(x+10)^2 + y^2 = 4$ is $(-10, 0)$ and radius is 2 Since $y = mx + c$ is tangent hence

$\left|\frac{0 - m(-10) - c}{\sqrt{1+m^2}}\right| = 2$

$\left|\frac{10m - c}{\sqrt{1+m^2}}\right| = 2$

$\left|\frac{10m - 16m}{\sqrt{1+m^2}}\right| = 2$

$6m = 2\sqrt{1+m^2}$

$3m = \sqrt{1+m^2}$

$9m^2 = 1 + m^2$

$m^2 = \frac{1}{8}$

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

$$c = 16m = \frac{16}{2\sqrt{2}}$$

$$m + c = \frac{16}{2\sqrt{2}} + \frac{1}{2\sqrt{2}} = \frac{17}{2\sqrt{2}}$$

$$4\sqrt{2}(m + c) = 34$$

Question: The mean of 6 numbers is 6.5 and there variance is 10.25. If 4 numbers are 2, 4, 5, 7. Find the other two numbers.

Answer: 10, 11

Solution:

$$\frac{a+b+c+d+e+f}{6} = 6.5$$

$$10.25 = \frac{\sum x_i^2}{6} - (6.5)^2$$

$$\Rightarrow \sum x_i^2 = 315$$

or $a^2 + b^2 = 221$

and $a + b = 21$

$\therefore a, b = 10, 11$