JEE-Main-17-03-2021-Shift-1 (Memory Based)

PHYSICS

Question: Diameter of plano-convex lens is 6 cm and thickness at the centre is 3 mm. If speed of light in material of lens is 2×10^8 m/s, the focal length of the lens is:

Options:

(a) 20 cm

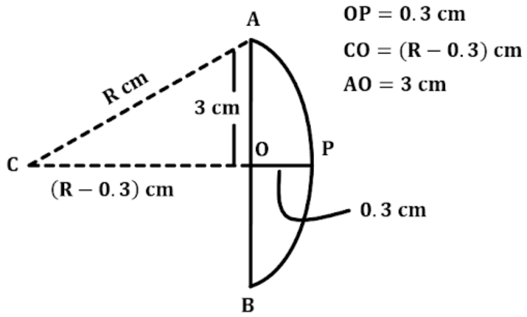
(b) 30 cm

(c) 10 cm

(d) 15 cm

Answer: (b)

Solution:



From diagram:

$R^2-(R-0.3)^2=9$

$\Rightarrow R^2-R^2\left(1-\frac{3}{10R}\right)^2=9$

Apply Result of binomial expression:

$\Rightarrow R^2-R^2\left(1-\frac{6}{10R}\right)=9$

$\Rightarrow R=+15\,cm$

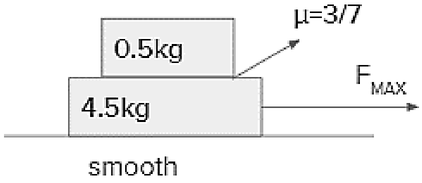
and $\mu_g=\frac{3\times10^8}{2\times10^8}=\frac{3}{2}=\mu_2$

Fold length $\frac{1}{f}=\left(\frac{\mu_2}{\mu_1}-1\right)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$

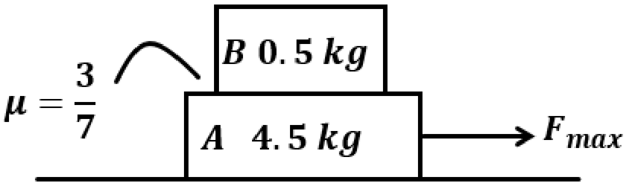
$\Rightarrow \frac{1}{f}=\left(\frac{3}{2}-1\right)\left(\frac{1}{\infty}-\frac{1}{(-15)}\right)=\frac{1}{30}$

$f=30\,\text{cm}$

Question: $F_{\max}$ such that both blocks more together.



Options:
(a) 21 N
(b) 40 N
(c) 38 N
(d) 10 N
Answer: (a)
Solution:



Maximum friction between block A & B:

$$f_{\max} = \mu m_B g$$

$$= \frac{3}{7} \times \frac{5}{10} \times \frac{98}{10}$$

$$f_{\max} = \frac{21}{10} N$$

Maximum acceleration for block B (as only friction will give acceleration to block B): -

$$a_{\max} = \frac{21}{10} \times \frac{10}{5} = \frac{21}{5} m/s^2$$

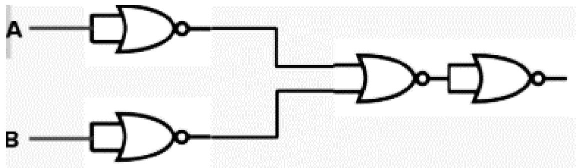
So, for blocks A and B to move together, both must move at maximum acceleration:

$$a_{\max} = \frac{21}{5} m/s^2$$

$$F_{\max} = (m_A + m_B) a_{\max} = 5 \times \frac{21}{5} = 21 N$$

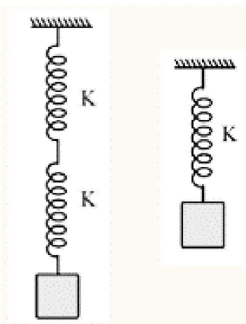
Question: In a metal conductor, 0.1 A current is flowing. The cross-section area is 5 mm^2. Drift velocity is given to be $2 \times 10^{-3} m/s$. Find free electron density.
Options:
(a) 625×10^{23}
(b) 62.5×10^{23}
(c) 500×10^{23}

(d) 400×10^{23}
Answer: (a)
Solution:
$I = n.e.A.v_d$
$\Rightarrow (0.1) = (n)(1.6\times10^{-19})(5\times10^{-6})(2\times10^{-3})$
$\Rightarrow n = \frac{10000}{16}\times10^{23}$
$n = 625\times10^{23}\ m^{-3}$

Question: Given diagram is equivalent to:


Options:
(a) OR gate
(b) AND gate
(c) NAND gate
(d) NOR gate
Answer: (c)
Solution:
Output of given diagram
$Y = \overline{\overline{\overline{A}+\overline{B}}} = \overline{A}+\overline{B} = \overline{A\cdot B}$
So, given combination is equivalent to NAND gate

Question: Given ratio of time period $\frac{T_1}{T_2}$ for the two systems shown here, is $\sqrt{x}$. Find x.



Answer: 2.00
Solution:
$T = 2\pi\sqrt{\frac{m}{k}}$
For spring block system

Case I: $K_{eq} = \frac{K}{2}$ (Series combination of springs)

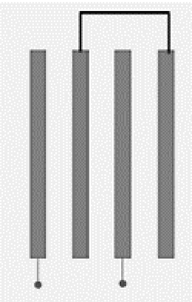
$$T_1 = 2\pi\sqrt{\frac{m}{(K/2)}}$$

Case II: $T_2 = 2\pi\sqrt{\frac{m}{K}}$

$$\Rightarrow \frac{T_1}{T_2} = \frac{2\pi\sqrt{\frac{2m}{K}}}{2\pi\sqrt{\frac{m}{K}}} = \sqrt{2}$$

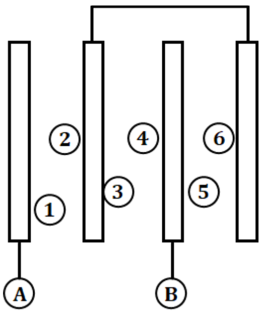
So, $x = 2$

Question: For each plate $l = 2$ cm & $b = \frac{3}{2}cm.$ If equivalent capacitance is $\frac{x\in_0}{d}$, where d is the distance between any two consecutive plates. Then find x.

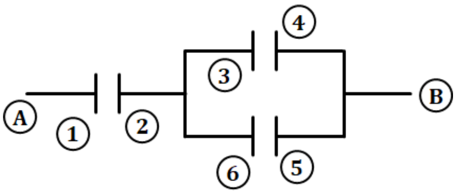


Answer: 2.00

Solution:



Equivalent Circuit:



$$\Rightarrow C_{AB} = \frac{(2C)\times(C)}{(2C+C)} = \frac{2}{3}C$$

(considering *l, b and d* in cm)

$$\Rightarrow C_{AB} = \frac{2}{3}\varepsilon_0 \frac{(2)(3/2)(10^{-4})}{d\times(10^{-2})}$$

$$\Rightarrow C_{AB} = \frac{2}{100} = \frac{\varepsilon_0}{d} = \frac{1}{50}\frac{\varepsilon_0}{d} = x\frac{\varepsilon_0}{d}$$

$$\Rightarrow x = \frac{1}{50} = 0.02\,\text{m} = 2\text{ cm}$$

Therefore, x = 2.

Question: Given $I = I_1 \sin\omega t + I_2 \cos\omega t$. The reading of ammeter is

Options:

(a) $\sqrt{\frac{I_1^2 + I_2^2}{2}}$

(b) $\sqrt{\frac{I_1 I_2}{I_1 + I_2}}$

(c) $\frac{I_1 + I_2}{2}$

(d) $\frac{|I_1 - I_2|2}{}$

Answer: (a)

Solution:

Need to find out rms value of current.

$$I = I_1 \sin\omega t + I_2 \cos\omega t$$

$$I = \sqrt{I_1^2 + I_2^2 + I_1 I_2 \cos(\frac{\pi}{2})}$$

$$I = \sqrt{I_1^2 + I_2^2}$$

$$I_{rms} = \frac{I}{\sqrt{2}}$$

$$I_{rms} = \frac{\sqrt{I_1^2 + I_2^2}}{\sqrt{2}}$$

$$= \sqrt{\frac{I_1^2 + I_2^2}{2}}$$

Question: An electron (e, m) and photon have same energy E then $\lambda_e : \lambda_p$ is?

Options:

(a) $\frac{1}{C}\sqrt{\frac{E}{2m}}$

(b) $\frac{1}{C}\sqrt{\frac{E}{m}}$

(c) $\frac{2}{C}\sqrt{\frac{E}{m}}$

(d) $\frac{1}{2C}\sqrt{\frac{E}{m}}$

Answer: (a)

Solution:

For electron

De-Broglie wavelength $\lambda_c = \frac{h}{p}$

Where p is momentum $p = mv$

Also by energy we have $E = \frac{1}{2}mv^2$

$\Rightarrow E = \frac{1}{2}\frac{p^2}{m}$

$\Rightarrow p = \sqrt{2mE}$

$\therefore \lambda_c = \frac{h}{\sqrt{2mE}}$

For photon energy $\Rightarrow E = \frac{hc}{\lambda}$

$\Rightarrow \lambda = \frac{hc}{E}$

$\therefore \frac{\lambda_c}{\lambda} = \frac{h}{\sqrt{2mE}}\frac{E}{hc}$

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

Question: The radius of Earth is R and escape speed is V_e. If the radius of Earth needs to be changed to nR comes 10 v. Find n?

Options:

(a) $\frac{1}{10}$

(b) 10

(c) $\frac{1}{100}$

(d) 100

Answer: (c)

Solution:

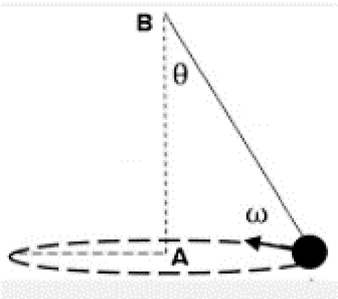
$$v_e \propto \frac{1}{\sqrt{r}}$$

$$\frac{v_e}{10v_e} = \sqrt{\frac{nR}{R}} \Rightarrow n = \frac{1}{100}$$

Question: Consider the conical pendulum shown in figure.

$\overrightarrow{L_A}$ = Angular Momentum about A

$\overrightarrow{L_B}$ = Angular Momentum about B.



Options:

(a) $\overrightarrow{L_A}$ is constant in magnitude as well as direction

(b) $\overrightarrow{L_B}$ is constant in magnitude as well as direction

(c) $\left|\vec{L}_B\right| = \left|\vec{L}_A\right|$

(d) $\hat{L}_B = \hat{L}_A$

Answer: (a)

Solution:

General equation: $\vec{L} = \vec{r} \times \vec{p}$

$\vec{L}_A$ will have the same magnitude an direction. But $\vec{L}_B$ will change in direction. $\vec{L}_A$ and $\vec{L}_B$ have different magnitude.

Question: If I current flows through the long solenoid with the core of relative permeability μ_r and number of turns per unit length is n, Find the magnetic field B inside the solenoid.

Given n = 1000 turns/m; $\mu_r = 500; \mu_0 = 4\pi \times 10^{-7}$ Tm / A, $I = 10\,A$

Options:

(a) 2π Tesla

(b) 3π Tesla

(c) 5π Tesla

(d) 7π Tesla

Answer: (a)

Solution:

In a long solenoid the magnetic field B is given by

$B = \mu_r \mu_0 nI$ where n = number of turns per unit length.

Given,

I = 10 A, n = 1000, $\mu_0 = 4\pi \times 10^{-7}\,Tm/A$

$\mu_r = 500$,

$B = 4\pi \times 10^{-7} \times 500 \times 1000 \times 10$

$B = 20\pi \times 10^{-1}$

$B = 2\pi$ Tesla

Question: If equivalent resistance of identical resistors in series combination is S and in parallel is combination is P. If S = n P, then find the minimum possible value of n?

Options:

(a) 1

(b) 2

(c) 0

(d) 4

Answer: (d)

Solution:

Let there are x number of identical resistors of resistance r.

When they in series

S = xr

When they are in parallel

$P = \frac{x}{r}$

Given,

$S = nP$

$xr = n.\frac{r}{x}$

$x^2 = n$

$n = x^2$

$x \in$ Integer

$x \neq 1$, (No combination will possible for this)

$x_{\min} = 2$

then

$n = 4$

Question: For a polyatomic ideal gas, and degree of freedom is 24.Find the ratio $\frac{C_p}{C_v}$.

Options:
(a) 1.01
(b) 1.03
(c) 1.05
(d) 1.08

Answer: (d)

Solution:

Given

$f = 24$ for polyatomic ideal gas

$$\frac{C_P}{C_V} = \frac{C_V + R}{C_V} = 1 + \frac{R}{C_V}$$

We know that

$$C_V = \frac{fR}{2}$$

$$\frac{C_P}{C_V} = 1 + \frac{R}{f\,R/2} = 1 + \frac{2}{f}$$

$$\frac{C_P}{C_V} = 1 + \frac{2}{24} = \frac{13}{12} \simeq 1.08$$

Question: A CARNOT engine operating between 400 K & 800 K does 1200 J of work in 1 cycle. Find heat extracted from source.

Options:

(a) 2400 J

(b) 3000 J

(c) 200 J

(d) 1500 J

Answer: (a)

Solution:

$T_{\text{sink}} = 400\,K$

$T_{\text{source}} = 800\,K$

$$\eta = \left(1 - \frac{T_{\text{sink}}}{T_{\text{source}}}\right)$$

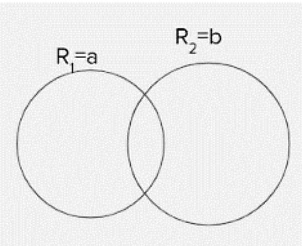
$$\eta\% = 1 - \frac{1}{2} = 50\%$$

$$\eta = \frac{W}{Q_{in}} \qquad (W = 1200\,J \text{ in one cycle})$$

$$\frac{1}{2} = \frac{1200}{Q_{in}}$$

$Q_{in} = 2400\,J$

Question: Find Radius of curvature of common surface when two soap bubble coalesce, if the surface tension is T



Options:

(a) $R = \frac{ab}{|a-b|}$

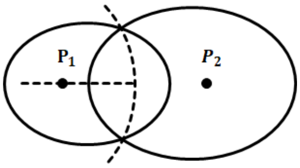
(b) $R = a + b$

(c) $R = |a-b|$

(d) $R = \sqrt{a^2 + b^2}$

Answer: (a)

Solution:



P_1 pressure inside bubble 1

P_2 pressure inside bubble 2

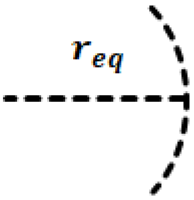
$$\Delta P_1 = \frac{4T}{a}$$

$$\Delta P_2 = \frac{4T}{b}$$

$$P_1 - P_0 = \frac{4T}{a}$$

$$P_2 - P_0 = \frac{4T}{b}$$

At common surface



$$P_1 - P_2 = \frac{4T}{r_{eq}}$$

$$\frac{4T}{a} - \frac{4T}{b} = \frac{4T}{r_{eq}}$$

$$\frac{1}{r_{eq}} = \frac{1}{a} - \frac{1}{b}$$

$$\frac{1}{r_{eq}} = \frac{b-a}{ab}$$

$$r_{eq} = \frac{ab}{b-a}$$

Best suited option is

$$r_{eq} = \frac{ab}{|b-a|}$$

Question: A body is rotating with 900 rpm. The angular velocity become 2460 rpm in 26 sec due to a constant angular acceleration. Total number of revolution during acceleration is.

Options:

(a) 728 rev

(b) 364 rev

(c) 1456 rev

(d) 182 rev

Answer: (a)

Solution:

$$\omega_i = 900\,rpm = \frac{900}{60}\,rev/s$$

$$\omega_f = 2460\,rpm = \frac{2460}{60}\,rev/s$$

$t = 26\,s$

We have

$$\omega_f = \omega_i + \alpha t$$

$$\frac{2460}{60} = \frac{900}{60} + \alpha(26)$$

$$\alpha \times 26 = \frac{2460-900}{60}$$

$$\alpha = 1\,rev/s^2$$

$$\theta = \omega_i t + \frac{1}{2}\alpha t^2$$

$$\theta = \frac{900}{60}\times 26 + \frac{1}{2}\times 1\times(26)^2$$

$$\theta = 390 + 338 = 728\,rev.$$

Question: Two polyatomic ideal gases are mixed together of temperature T_1 and T_2, in a thermally insulated vessel at constant volume ,if the number of molecules N_1 and N_2, mass of particles m_1 and m_2, degree of freedom f_1 and f_2. Find final temperature of mixture ?

Options:

(a) $\frac{N_1T_1 + N_2T_2}{N_1 + N_2}$

(b) $\frac{N_1f_1T_1 + N_2f_2T_2}{N_1f_1 + N_2f_2}$

(c) $\frac{f_1T_1 + f_2T_2}{f_1 + f_2}$

(d) $\frac{T_1 + T_2}{2}$

Answer: (b)

Solution:

Keeping volume constant and gas is in thermally insulated vessel.

The total internal energy of gas before mixing is

$$U_i = n_1\frac{f_1}{2}RT_1 + \frac{n_2f_2R}{2}T_2$$

$$U_i = \frac{N_1}{N_2}\frac{f_1}{N_A}\frac{f_1}{2}R.T_1 + \frac{N_2}{N_A}\frac{f_2}{2}.RT_2$$

After mixing, let the temperature be T_f

$$U_f = \frac{N_1}{N_A}\frac{f_1 RT_f}{2} + \frac{N_2}{N_A}\frac{f_2}{2}RT_f$$

Vessel is thermally insulated

So, $U_i = U_f$

$$\frac{N_1 f_1 RT_f}{2N_A} + \frac{N_2 f_2 RT_f}{2N_A} = \frac{N_1 f_1 RT_1 + N_2 f_2 RT_2}{2N_A}$$

$$\left(N_2 f_2 + N_1 f_1\right)T_f = N_1 f_1 T_1 + N_2 f_2 T_2$$

$$T_f = \frac{N_1 f_1 T_1 + N_2 f_2 T_2}{N_1 f_1 + N_2 f_2}$$

Question: A particle accelerates from rest with a uniform acceleration of ‘α’ & then decelerates to rest with a constant deceleration ‘β’. Find total displacement. Given total time is T.

Options:

(a) $\frac{\alpha\beta T^2}{2\left(\alpha+\beta\right)}$

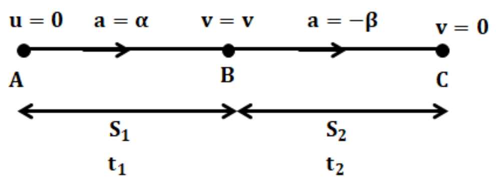
(b) $\frac{\alpha\beta T^2}{\left(\alpha+\beta\right)}$

(c) $\alpha T^2 + \beta T^2$

(d) $\frac{\alpha T^2 + \beta T^2}{2}$

Answer: (a)

Solution:



$t_1 + t_2 = T \Rightarrow t_2 = T - t_1$ **…** (i)

$v = \alpha t_1$ $\quad$ $O = v - \beta t_2$

$v = \beta t_2$

$\alpha t_1 = \beta t_2$ … (ii)

Solving equation (i) and (ii)

$$t_1 = \frac{\beta}{\alpha+\beta}.T$$

$t_2 = \frac{\alpha}{\alpha+\beta}.T$

Total displacement $'s' = s_1 + s_2$

$s = \frac{1}{2}\alpha t_1^2 + \frac{1}{2}\beta t_2^2$

$s = \frac{1}{2}\left\{\alpha.\left(\frac{\beta}{\alpha+\beta}T\right)^2 + \beta.\left(\frac{\alpha}{\alpha+\beta}\cdot T\right)^2\right\}$

$s = \frac{1}{2}\cdot\frac{\alpha\beta}{(\alpha+\beta)}T^2$

Question: Two identical metallic wires are connected one after other. Find their k_{eq}?

Options:

(a) $k_1 + k_2$

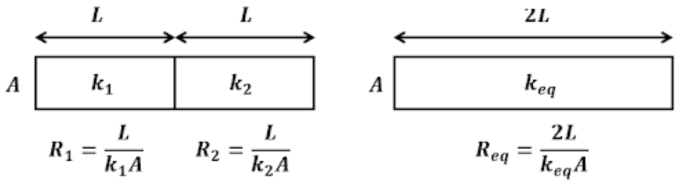
(b) $\frac{k_1 k_2}{k_1 + k_2}$

(c) $\frac{k_1 + k_2}{2}$

(d) $\frac{2k_1 k_2}{k_1 + k_2}$

Answer: (d)

Solution:



$R_{eq} = R_1 + R_2$

$\frac{2L}{k_{eq}} = \frac{L}{k_1 A} + \frac{L}{k_2 A}$

$\frac{2}{k_{eq}} = \frac{1}{k_1} + \frac{1}{k_2}$

$k_{eq} = \frac{2k_1 k_2}{k_1 + k_2}$

Question: In a SHM, the distance from mean position where energy is?

Options:

(a) A

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

(c) $\frac{A}{\sqrt{2}}$

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

Answer: (c)

Solution:

Equation of S.H.M

$x = A\sin\omega t$

$K.E = \frac{1}{2}mA^2\omega^2\cos^2\omega t$

$P.E = \frac{1}{2}KA^2\sin^2\omega t$

From questions.

K.E = P.E

$\frac{1}{2}mA^2\omega^2\cos^2\omega t = \frac{1}{2}kA^2\sin^2\omega t$

$m\omega^2\cos^2\omega t = k\sin^2\omega t$

$m\omega^2\cos^2\omega t = m\omega^2\sin^2\omega t \quad \left[k = m\omega^2\right]$

$\tan^2\omega t = 1$

$\tan\omega t = 1$

$\omega t = \frac{\pi}{4}$

$x = A\sin\left(\pi/4\right)$

$x = \frac{A}{\sqrt{2}}$

Question: If V_n is the speed of an electron in n^{th} orbit of a hydrogen atom then correct proportionality is?

Options:

(a) $V_n \alpha\, n^2$

(b) $V_n \alpha\, n$

(c) $V_n \alpha \frac{1}{n}$

(d) $V_n \alpha \frac{1}{n^2}$

Answer: (c)

Solution:

Speed of electron in nth orbit of a hydrogen atom is given by

$$V_n = \frac{2.19\times10^6}{n} m/s$$

$$V_n \propto \frac{1}{n}$$

Question: A boy moves a ball of mass 0.5 kg in horizontal rough surface with 20 m/s. It collides and moves with 5% of its initial kinetic energy. Find the final speed?

Options:

(a) $\sqrt{5}\, m/s$

(b) $4\sqrt{5}\, m/s$

(c) $2\sqrt{5}\, m/s$

(d) 2 m/s

Answer: (c)

Solution:

Given

$m = 0.5\, kg$

$v_i = 20\, m/s$

$$K.E_i = \frac{1}{2} m V_i^2$$

After collision ball moves by 5% of initial kinetic energy.

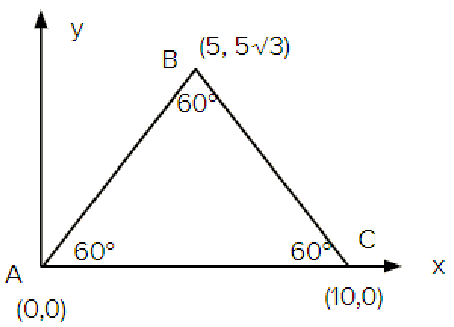
$K.E_f = 0.05\, K.E_i$

$$\frac{1}{2} m V_f^2 = 0.05 \times \frac{1}{2} \times m V_i^2$$

$$V_f = \sqrt{0.05\times(20)^2}$$

$$V_f = 2\sqrt{5}\, m/s$$

Question: A force $\vec{F} = \left(4\hat{i} - 3\hat{j}\right)N$ acts on vertex B. $\tau_O =$ Torque about O. $\tau_Q =$ Torque about Q.



Options:

(a) $\tau_0 = \left(20\sqrt{3} + 15\right) Nm\, \tau_Q = \left(20\sqrt{3} - 15\right) Nm$

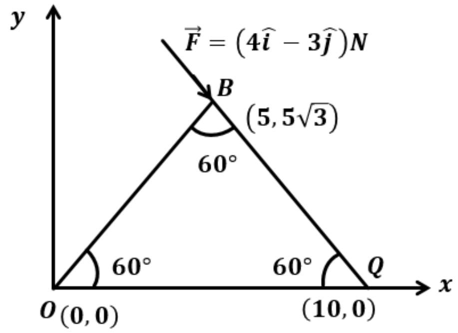
(b) $\tau_0 = \left(20\sqrt{3} - 15\right) Nm\, \tau_Q = \left(20\sqrt{3} + 15\right) Nm$

(c) $\tau_0 = \left(20\sqrt{3} - 15\right) Nm\, \tau_Q = \left(20\sqrt{3} - 15\right) Nm$

(d) $\tau_0 = \left(20\sqrt{3} + 15\right) Nm\, \tau_Q = \left(20\sqrt{3} + 15\right) Nm$

Answer: (a)

Solution:



$\vec{\tau} = \vec{r} \times \vec{F}$

$\vec{\tau}_0 = \vec{r}_{BO} \times \vec{F}$

$\vec{r}_{BO} = \left(5\hat{i} + 5\sqrt{3}\,\hat{j}\right) m$

$\vec{\tau}_0 = \left(5\hat{i} + 5\sqrt{3}\right) \times \left(4\hat{i} - 3\hat{j}\right) N.m$

$\vec{\tau}_0 = \left(-15 - 20\sqrt{3}\right)\hat{k}.\, Nm$

$\left|\vec{\tau}_0\right| = \left(20\sqrt{3} + 15\right) Nm.$

$\vec{\tau}_{PQ} = \vec{r}_{BQ} \times \vec{F}$

$\vec{r}_{BQ} = \left(-5\hat{i} + 5\sqrt{3}\,\hat{j}\right) m$

$\vec{\tau}_Q = \left(-5\hat{i} + 5\sqrt{3}\,\hat{j}\right) \times \left(4\hat{i} - 3\hat{j}\right) N.m$

$\vec{\tau}_Q = \left(15 - 20\sqrt{3}\right)\hat{k}\ Nm$

$\left|\vec{\tau}_Q\right| = \left(20\sqrt{3} - 15\right) N.m$

$\left|\vec{\tau}_O\right| = \left(20\sqrt{3} + 15\right) Nm$

$\left|\vec{\tau}_Q\right| = \left(20\sqrt{3} - 15\right) N.m$

JEE-Main-17-03-2021-Shift-1 (Memory Based)

CHEMISTRY

Question: IUPAC name of mesityl oxide
Options:

(a) 4-methyl pent-3-en-2-one

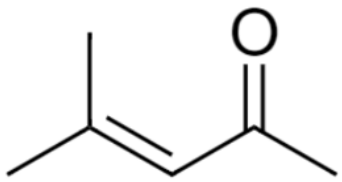
(b) 3-methyl pent-4-en-1-one

(c) 4-methyl pent-5-en-2-one

(d) 2-ethyl hent-2-ene-3-one

Answer: (a)

Solution:



IUPAC name of mesityl oxide is 4-methyl pent-3-en-2-one

Question: S1: Potassium permanganate decompose to give potassium manganate at 500 K.

S2: Both permanganate and manganate are tetrahedral and paramagnetic
Options:

(a) Both S1 and S2 are correct

(b) S1 is correct, S2 is wrong

(c) S2 is correct, S1 is wrong

(d) Both S1 and S2 are wrong

Answer: (b)

Solution:

S1 is correct:

$2KMnO_4 \xrightarrow{500K} K_2MnO_4 + MnO_2 + O_2$

S2 is wrong because MnO_4^- and MnO_4^{2-} are tetrahedral but MnO_4^{2-} contains one unpaired electron hence it is a paramagnetic while MnO_4^- has no unpaired electron so it is diamagnetic

Question: Magnetic moment of Mn^{2+}

Options:

(a) 2.7 BM

(b) 8.5 BM

(c) 5.9 BM

(d) 9.8 BM

Answer: (c)

Solution: $Mn^{2+} = 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^0\ 3d^5$

n = 5

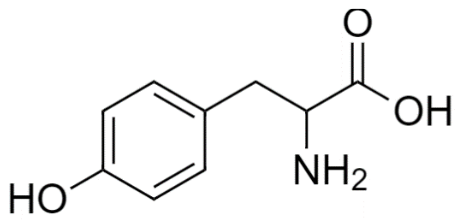
$\mu = \sqrt{n(n+2)}$

$\sqrt{5(5+2)} = \sqrt{35} = 5.9\,\text{BM}$

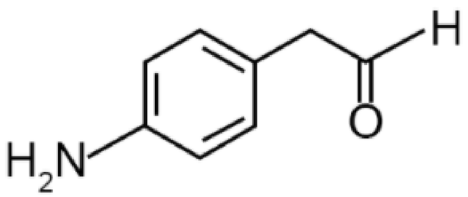
Question: Structure of tyrosine

Options:

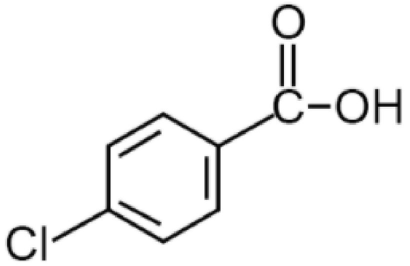
(a)



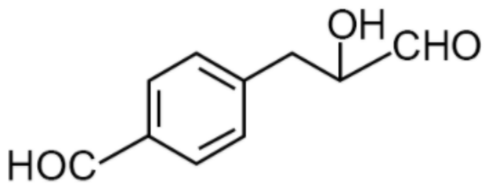
(b)



(c)

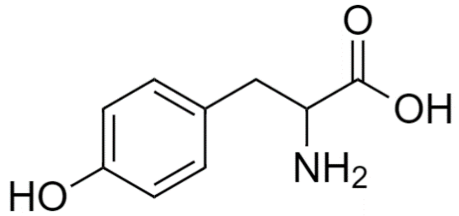


(d)



Answer: (a)

Solution:



Question: Benzene chloride with NaOH give phenoxide ion. What is the temperature and pressure of this reaction?

Options:

(a) 200 K, 443 atm

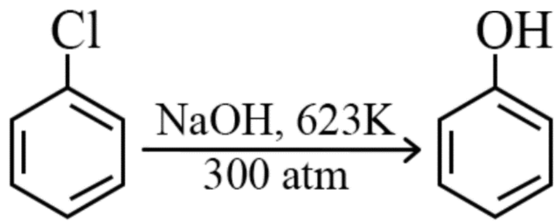
(b) 350 K, 200 atm

(c) 500 K, 100 atm

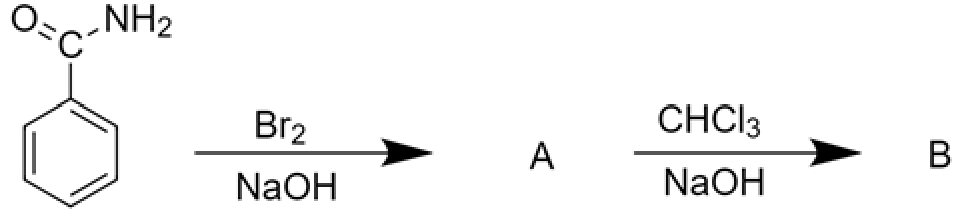
(d) 623 K, 300 atm

Answer: (d)

Solution:

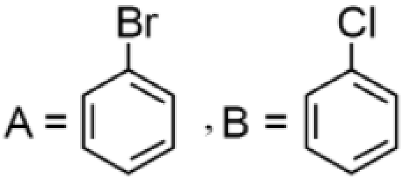


Question: What are A and B?

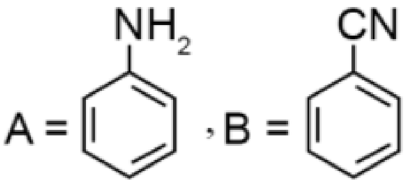


Options:

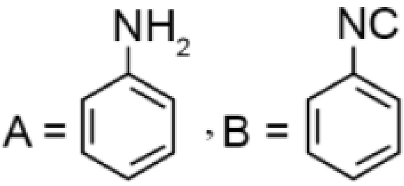
(a)



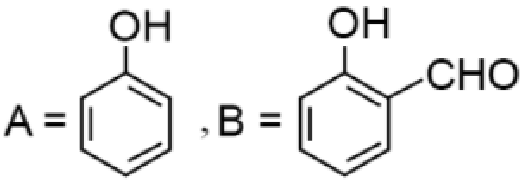
(b)



(c)

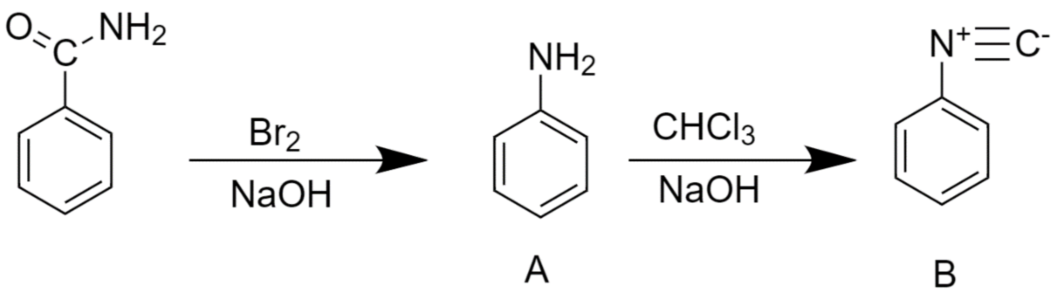


(d)



Answer: (c)

Solution:



Question: The colloid in which gas is the dispersed phase and solid is the dispersion medium:
Options:

(a) Gel

(b) Solid foam

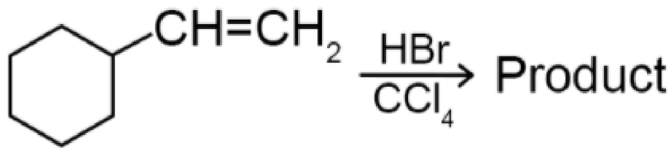
(c) Aerosol

(d) Foam

Answer: (b)

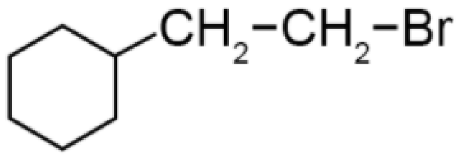
Solution: Solid foam

Question: What will be the major product?

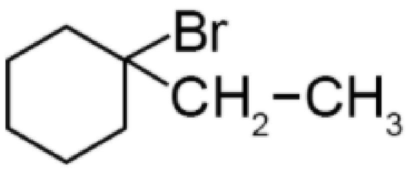


Options:

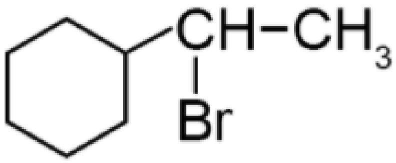
(a)



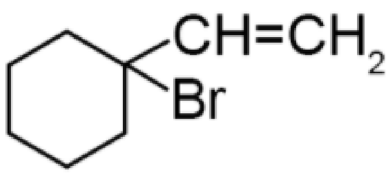
(b)



(c)

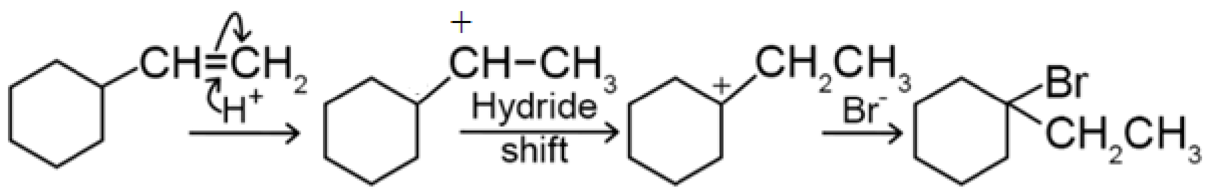


(d)



Answer: (b)

Solution:



Question: Two non-reacting gases CH_4 of mass 6.4 g and CO_2 of mass 8.8 gm is mixed in a vessel of volume 10 litre at 27°C. The pressure in KPa is?

Options:

(a) 149.96

(b) 148

(c) 14996

(d) 1.48

Answer: (a)

Solution:

Moles of $CH_4 = \frac{6.4}{16} = 0.4$ mol

Moles of $CO_2 = \frac{8.8}{44} = 0.2$ mol

According to Dalton's law

$P_{total} = P_1 + P_2$

$P_{total} = n_1\frac{RT}{V} + n_2\frac{RT}{V} = (n_1 + n_2)\frac{RT}{V}$

$= \frac{0.6 \times 0.0821 \times 300}{10} = 1.48\,atm$

= 149.96 KPa

Question:

ΔH_f of Al_2O_3 = – 1290 KJ/mol,
ΔH_f of CaO = – 675 KJ/mol
$3CaO + 2Al \rightarrow Al_2O_3 + 3Ca$
Calculate ΔH_f for this reaction.

Options:

(a) +735 kJ

(b) –735 kJ

(c) +3315 kJ

(d) –3315 kJ

Answer: (a)

Solution:

$2Al + \frac{3}{2}O_2 \rightarrow Al_2O_3 \quad \Delta Hf_1 = -1290$ kJ

$Ca + \frac{1}{2}O_2 \rightarrow CaO \quad \Delta Hf_2 = -675$ kJ

$3CaO + 2Al \rightarrow Al_2O_3 + 3Ca \quad \Delta H_3$

$\Delta H_3 = \Delta Hf_1 - 3(\Delta Hf_2)$

$= -1290 - 3(-675) = +735$ kJ

Question: Composition of reducing smog:

Options:

(a) SO_2, Smoke, fog

(b) CH_2=CH-CHO, Smoke, fog

(c) N_2O_3, Smoke, fog

(d) O_3, Smoke, fog

Answer: (a)

Solution: Reducing smog is characterised by sulphur dioxide and particulars like, smoke, fog

Question: HA is a weak acid. No. of moles= 0.001, $K_a = 2 \times 10^{-6}$,
HCl is added with molarity 0.01 and the solution is made 1 litre. Calculate degree of dissociation of HA

Options:

(a) 0.02

(b) 0.2

(c) 2×10^{-3}

(d) 2×10^{-4}

Answer: (d)

Solution:

HA $\rightleftharpoons$	H^+ +	A^-
1	0	0
$C(1-\alpha)$	$C\alpha$	$C\alpha$

$$Ka = \frac{C\alpha^2}{1-\alpha} \approx C\alpha^2$$

On adding, HCl, $[H^+] = 0.01$

$$2\times10^{-6}=\frac{[H^+][A^-]}{C(1-\alpha)}=0.01\times\alpha$$

$$\alpha=\frac{2\times10^{-6}}{0.01}=2\times10^{-4}$$

Question: The order of electron gain enthalpy in group 17 element is:
Options:

(a) F < Cl < Br < I

(b) I < Br < F < Cl

(c) Br < Cl < F < I

(d) I < Cl < Br < F

Answer: (b)

Solution: Iodine has lowest electron gain enthalpy amongst halogens.

Electron gain enthalpy of F is less negative than, Cl because of its small size. But on going from Cl to I, due to decreased in electronegativity electron gain enthalpy also decreases

Question: Conductivity order of ions in aqueous solution

Li^+, Na^+, K^+, Rb^+, Cs^+
Options:

(a) $Li^+ < Na^+ < K^+ < Rb^+ < Cs^+$

(b) $Na^+ > Li^+ > Rb^+ > K^+ > Cs^+$

(c) $Li^+ > Na^+ > K^+ > Rb^+ > Cs^+$

(d) $K^+ > Rb^+ > Cs^+ > Na^+ > Li^+$

Answer: (a)

Solution: Cs^+, being least hydrated shows maximum ionic, mobility and thus highest conductivity

Question: Find mole fraction of solute in aqueous solution with the molality 100 mol/kg.
Options:

(a) 1.78

(b) 0.24

(c) 0.643

(d) 2.57

Answer: (c)

Solution: 100 mol/kg means 100 moles of solute in 1 kg of solvent (water)

Number of moles of solute = 100

Number of moles of solvent = $\frac{1000}{18}$ = 55.5

Mole fraction of solute = $\frac{100}{100+55.5}$ = 0.643

Question: Which energy level of C^{5+} ion will have the same energy as that of ground state of hydrogen atom?

Options:

(a) 3

(b) 4

(c) 5

(d) 6

Answer: (d)

Solution:

$$E = -\frac{13.6Z^2}{n^2}$$

$$\frac{Z_1^2}{n_1^2} = \frac{Z_2^2}{n_2^2}$$

$$\frac{6^2}{n_1^2} = \frac{1^2}{1^2}$$

$\Rightarrow n_1 = 6$

Question: Which of the following is not a Lewis base?

Options:

(a) PCl_5

(b) ClF_3

(c) NF_3

(d) SF_4

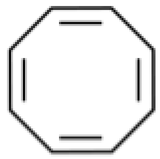
Answer: (a)

Solution: PCl_5 has empty d-orbital in valence shell. So it can accept a pair of electrons from Lewis base

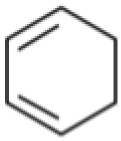
Hence, it acts as Lewis acid

Question: Which of the following is aromatic?
Options:

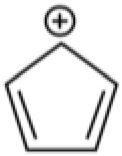
(a)



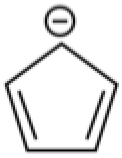
(b)



(c)



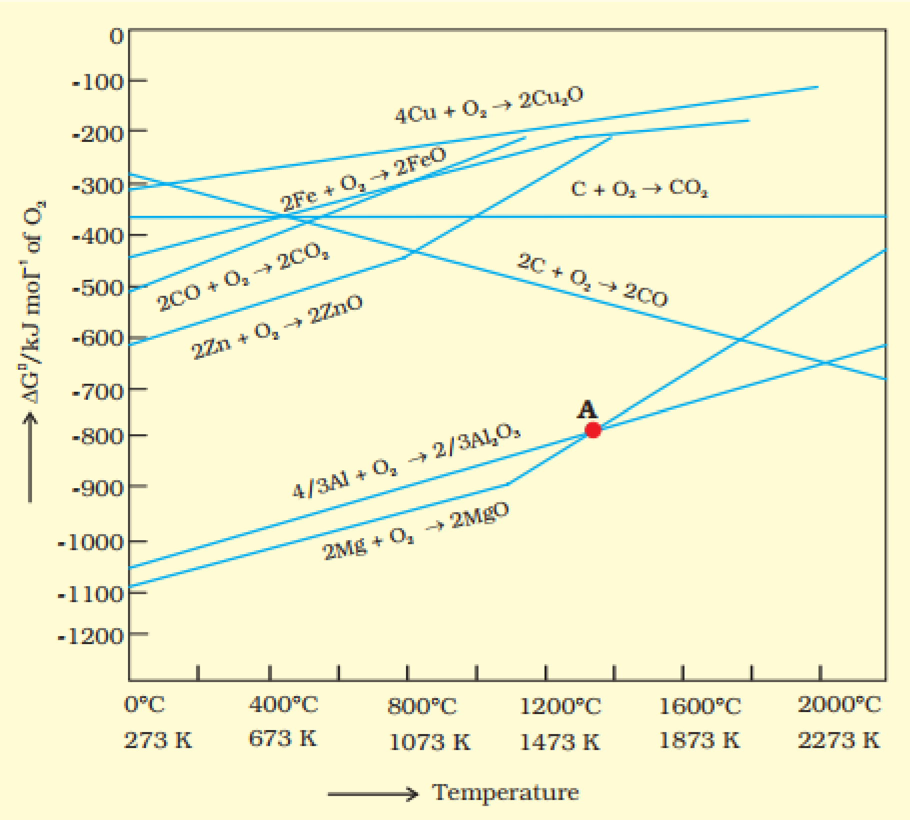
(d)



Answer: (d)

Solution: It has (4n + 2) electrons i.e., 6π electrons and satisfies Huckel's rule of aromaticity

Question: What does the point A signify?
What does the abrupt change in slope of the graph signify?



Options:

(a) Point A signifies equilibrium and abrupt change in slope show phase change

(b) Point A signifies chemical reaction and abrupt change in slope show end of reaction

(c) Point A signifies melting and change is slope show vaporisation

(d) Point A signifies no reaction and change is slope show vaporisation

Answer: (a)

Solution: Point A signifies equilibrium between one metal and the metal oxide of two graphs abrupt change in the slope signifies melting of the metal corresponds to the graph

Question: Identify the shape that contains 3 bond pairs and 2 lone pair
Options:

(a) Regular

(b) See saw

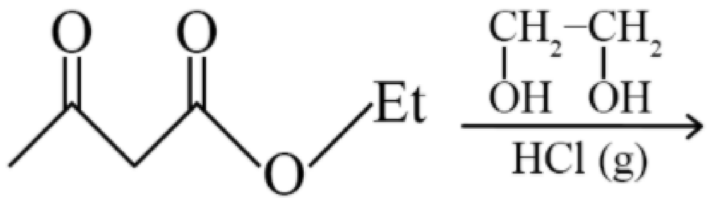
(c) T-shaped

(d) Linear

Answer: (c)

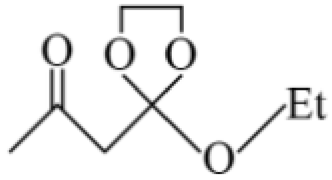
Solution: T-shaped contains 3 bond pairs and 2 lone pair

Question: What will be the major product

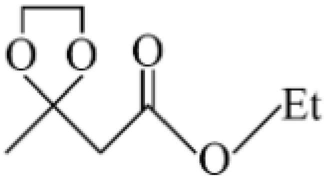


Options:

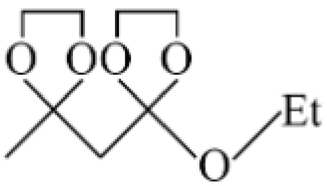
(a)



(b)



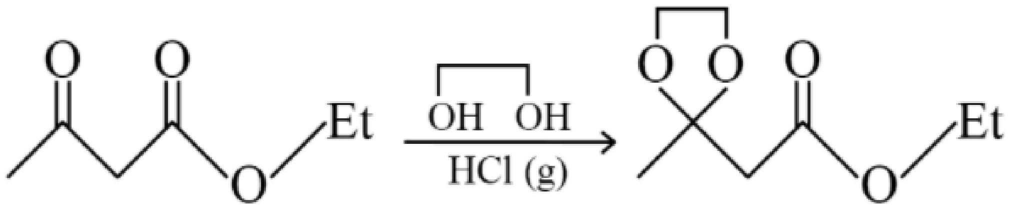
(c)



(d) None of these

Answer: (b)

Solution:



Ester group will not react, only keto group will react

Question: Number of radial nodes if n = 4 and m = –3

Options:

(a) 3

(b) 2

(c) 1

(d) 0

Answer: (d)

Solution: Radial node = $n - l - 1 = 0$

JEE-Main-17-03-2021-Shift-1 (Memory Based)

MATHEMATICS

Question: Inverse of $y = 5^{\log x}$

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

$y = x^{\log 5}$

$\log y = \log 5 \ \log x$

$\log x = \log_5 y$

$x = e^{\log_5 y}$

$\Rightarrow$ Inverse is $y = e^{\log_5 x} = x^{\log_5 e}$

Question: Plane consisting of y axis and passing through $(1,2,3)$

Options:
(a)
(b)
(c)
(d)
Answer: ()
Solution:
Equation of plane is $ax + by + cz = 0$

$\because$ Plane contains y-axis

$\therefore b = 0$

$\Rightarrow ax + cz = 0$ passes through (1, 2, 3)

$a + 3c = 0 \Rightarrow a = -3c$

$\therefore$ Equation of plane is $3x - z = 0$

Question: $4 + \cfrac{1}{5 + \cfrac{1}{4 + \cfrac{1}{5 + \ldots\infty}}} = ?$

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

$$y = 4 + \frac{1}{5 + \frac{1}{y}} \Rightarrow y = 4 + \frac{y}{5y+1}$$

$$5y^2 + y = 21y + 4$$
$$\Rightarrow 5y^2 - 20y - 4 = 0$$

$$y = \frac{20 \pm \sqrt{400+80}}{10} = \frac{20 \pm 4\sqrt{30}}{10} = \frac{10 \pm 2\sqrt{30}}{5}$$

$$\because\ y > 4 \Rightarrow y = \frac{10 + 2\sqrt{30}}{5} = \frac{10 + \sqrt{120}}{5}$$

Question: If $A = \begin{pmatrix} 0 & \sin\alpha \\ \sin\alpha & 0 \end{pmatrix}$ and $\det\left(A^2 - \frac{1}{2}I\right) = 0$ then a possible value of α is

Options:
(a) $\frac{\pi}{4}$
(b) $\frac{\pi}{2}$
(c) $\frac{\pi}{3}$
(d)
Answer: (a)
Solution:

$$A = \begin{bmatrix} 0 & \sin\alpha \\ \sin\alpha & 0 \end{bmatrix}$$

$$A^2 = \begin{bmatrix} 0 & \sin\alpha \\ \sin\alpha & 0 \end{bmatrix}\begin{bmatrix} 0 & \sin\alpha \\ \sin\alpha & 0 \end{bmatrix} = \begin{bmatrix} \sin^2\alpha & 0 \\ 0 & \sin^2\alpha \end{bmatrix}$$

$$\because\ A^2 - \frac{1}{2}I = \begin{bmatrix} \sin^2\alpha - \frac{1}{2} & 0 \\ 0 & \sin^2\alpha - \frac{1}{2} \end{bmatrix}$$

$\therefore \det\left(A^2 - \frac{1}{2}I\right) = 0$

$\Rightarrow \sin^2 \alpha = \frac{1}{2}$

$\Rightarrow \sin \alpha = \pm\frac{1}{\sqrt{2}} \Rightarrow \alpha = \frac{\pi}{4}$

Question: Two dice with faces 1, 2, 3, 5, 7, 11 when rolled. Find the probability that the sum of the top faces is less or equal to 8

Options:

(a)

(b)

(c)

(d)

Answer: ()

Solution:

Total cases = $6 \times 6 = 36$

Favourable cases = $5+4+4+3+1=17$

$\therefore$ Required probability = $\frac{17}{36}$

Question: $\frac{dy}{dx} = xy - 1 + x - y, y(0) = 0$ then find $y(1)$

Options:

(a)

(b)

(c)

(d)

Answer: ()

Solution:

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

$\int \frac{dy}{(y+1)} = \int (x-1)\,dx$

$\Rightarrow \ln(y+1) = \frac{x^2}{2} - x + c$

$\Rightarrow c = 0$

$\therefore \ln(y+1)=\frac{x^2}{2}-x$

At $x=1 \Rightarrow y=-1+e^{\frac{-1}{2}}$

Question: $\lim_{x\to 0^+} \frac{\left(\cos^{-1}\left(x-[x]^2\right)\right)\sin^{-1}\left(x-[x]^2\right)}{x-x^3}$

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

$$\lim_{x\to 0^+} \frac{\cos^{-1}(x)\cdot\sin^{-1}(x)}{x-x^3}=\lim_{x\to 0^+}\frac{\pi}{2}\cdot\frac{\sin^{-1}(x)}{x}$$

$$=\lim_{x\to 0^+}\left(\frac{\pi}{2}\right)\cdot\frac{1}{\sqrt{1-x^2}}=\frac{\pi}{2}$$

Question: if $2x-y+1=0$ is tangent to circle at $(2,5)$ and center of circle lie on $x-2y=4$, then radius of circle is.
Options:
(a)
(b)
(c)
(d)
Answer: ()
Solution:
Equation of normal passing through (2, 5) is $x+2y=12$

Let centre be (h,k)

$\therefore h-2k=4$
$h+2k=12$

$h=8,\ k=2$

$\therefore$ Radius $=\sqrt{36+9}=\sqrt{45}=3\sqrt{5}$

Question: $z, iz, z+iz$ are vertices of a Δ. Find its area.

Options:

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

(b) $\frac{1}{2}|z|^2$

(c) 1

(d) $\frac{1}{2}|z+iz|^2$

Answer: (b)

Solution:

If z is any complex number, iz will be a number of equal magnitude rotated by $90°$

Thus, Δ is right angled Δ with sides z & iz and hypotenuse $z+iz$

$$\therefore \quad \text{Area} = \left|\frac{1}{2}\times z\times iz\right| = \frac{|z|^2}{2}$$

Question: $g(\alpha)=\int^{\frac{\pi}{3}} \frac{\sin^{\alpha} x}{\sin^{\alpha} x+\cos^{\alpha} x} dx$ then which of the following is correct ?

Options:

(a) $g(\alpha)$ is increasing

(b) $g(\alpha)$ is decreasing

(c) $g(\alpha)$ has point of $x=\frac{-1}{2}$ as point of confection

(d) $g(\alpha)$ is an even function

Answer: (d)

Solution:

$$g(\alpha)=\int_{\frac{\pi}{6}}^{\frac{\pi}{3}} \frac{\sin^{\alpha} x}{\sin^{\alpha} x+\cos^{\alpha} x} dx=\int_{\frac{\pi}{6}}^{\frac{\pi}{3}} \frac{\cos^{\alpha} x}{\sin^{\alpha} x+\cos^{\alpha} x} dx$$

$$\therefore 2g(\alpha)=\int_{\frac{\pi}{6}}^{\frac{\pi}{3}} dx=\frac{\pi}{6}$$

$$\Rightarrow g(\alpha)=\frac{\pi}{12} \Rightarrow \text{ even function}$$

Question: $x^2+y^2-10x-10y+41=0$ and $x^2+y^2-16x-10y+80=0$ are two circles which of the following is NOT correct.

Options:

(a) Distance between centers is equal to average of radii

(b) Both circles passes through centres of each other

(c) Centres of each circle is contained in other circle

(d) Both circles intersect at 2 points

Answer: (c)

Solution:

$C_1(5,5)\ ;\ r_1=3\ ;\ C_2(8,5)\ ;\ r_2=3$

$$\Rightarrow C_1C_2=\sqrt{9}=3=\frac{r_1+r_2}{2}$$

Also, $|r_1-r_2|<C_1C_2<r_1+r_2\Rightarrow$ intersect at two points

Also, both circles passes through centres of each other

Question: $\cot^{-1}(\alpha)=\cot^{-1}(2)+\cot^{-1}(8)+\cot^{-1}(16)+\cot^{-1}(32)+\ldots$ upto 100 terms, then $\alpha=?$

Answer: 1.01

Solution:

$\cot^{-1}(\alpha)=\cot^{-1}(2)+\cot^{-1}(8)+\cot^{-1}(18)+\cot^{-1}(32)+\ldots$ 100 terms

$$=\sum_{r=1}^{100}\cot^{-1}(2r^2)=\sum_{r=1}^{100}\tan^{-1}\left(\frac{1}{2r^2}\right)$$

$$=\sum_{r=1}^{100}\tan^{-1}\left[\frac{(2r+1)-(2r-1)}{1+(2r+1)(2r-1)}\right]$$

$$=\sum_{r=1}^{100}\tan^{-1}(2r+1)-\tan^{-1}(2r-1)$$

$$=\tan^{-1}(3)-\tan^{-1}(1)+\tan^{-1}(5)-\tan^{-1}(3)+\ldots\tan^{-1}(201)-\tan^{-1}(1098)$$

$$=\tan^{-1}(201)-\tan^{-1}(1)$$

$$=\tan^{-1}\left(\frac{200}{1+201}\right)=\tan^{-1}\left(\frac{100}{101}\right)=\cot^{-1}\left(\frac{101}{100}\right)$$

$$\Rightarrow\alpha=\frac{101}{100}=1.01$$

Question: $kx+y+z=1, x+ky+z=k, x+y+kz=k^2$ be system of equations with no solution, then $k=$

Answer: -2.00

Solution:

$$\begin{vmatrix} k & 1 & 1 \\ 1 & k & 1 \\ 1 & 1 & k \end{vmatrix} = 0$$

$$\Rightarrow k\left(k^2-1\right)-(k-1)+(1-k)=0$$

$$(k-1)\left[k^2+k-2\right]=0$$
$$k=1,-2$$

But at $k=1$, equation becomes same, so rejected

$$\therefore\ k=-2$$

Question: If $f(x)=\dfrac{(\cos(\sin x)-\cos x)}{x^4}$ is continuous over the domain and $f(0)=\dfrac{1}{k}, k=?$

Answer: 6.00

Solution:

$\because f(x)$ is continuous

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

$$=\lim_{x\to 0}\frac{2\sin\left(\frac{x+\sin x}{2}\right)\sin\left(\frac{x-\sin x}{2}\right)}{x^4}$$

$$=\lim_{x\to 0}\frac{2\left(x^2-\sin^2 x\right)}{4x^4}$$

$$=\lim_{x\to 0}\frac{1}{2}\left[\frac{2x-\sin 2x}{4x^3}\right]$$

$$=\lim_{x\to 0}\frac{1}{8}\left[\frac{2-2\cos 2x}{3x^2}\right]=\frac{1}{6}$$

$$\Rightarrow k=6$$

Question: $\left(x+x^{\log_2 x}\right)^7$ has fourth term 4480 then $x=$

Answer: 2.00

Solution:

$$T_{r+1}={}^7C_r\,(x)^{7-r}\cdot\left(x^{\log_2 x}\right)^r$$

$$\because T_4=4480$$

$$\therefore\ {}^7C_3x^4\cdot x^{3\log_2 x}=4480$$

$\Rightarrow x^{4+3\log_2 x}=128=2^7$

$\Rightarrow x=2$

Question: $(2021)^{3762}$ is divided by 17, find the remainder.

Answer: 4.00

Solution:

$(2021)^{3762}=(2023-2)^{3762}=(17k-2)^{3762}$

Above expression has remainder $(2)^{3762}$

$\Rightarrow (2)^{3762}=(2)^{3760}\cdot 4=(16)^{940}\cdot 4=(17-1)^{940}\cdot 4$

Above expression has remainder $(1)^{940}\cdot 4=4$

Question: Team A contains 7 boys and n girls, Team B has 4 boys and 6 girls. If each boy of Team A plays one match with each half of Team B and each girl of Team A plays one match with every girl of Team 'B' and total matches are 52. Find 'n'

Answer: 4.00

Solution:

Team A $\Rightarrow$ 7 boys and n girls

Team B $\Rightarrow$ 4 boys and 6 girls

$\therefore (7\times 4)+(n\times 6)=52$

$\Rightarrow 6n=24$

$\Rightarrow n=4$

Question: $\tan^{-1}(x+1)+\cot^{-1}\left(\frac{1}{x-1}\right)=\tan^{-1}\frac{8}{31}$, Then sum of all values 'x'satisfy

Answer: -8.00

Solution:

$\cot^{-1}\left(\frac{1}{x-1}\right)=\tan^{-1}\left(\frac{8}{31}\right)-\tan^{-1}(x+1)$

$=\tan^{-1}\left[\frac{\frac{8}{31}-(x+1)}{1+\frac{8}{31}(x+1)}\right]$

$\cot^{-1}\left(\frac{1}{x-1}\right)=\tan^{-1}\left[\frac{-31x-23}{39+8x}\right]$

$\Rightarrow (39+8x)(x-1)+(31x+23)=0$

$\Rightarrow 8x^2+31x-39+31x+23=0$

$\Rightarrow 8x^2+62x-16=0$

$\Rightarrow 4x^2+31x-8=0$

$\Rightarrow 4x^2+32x-x-8=0$

$\Rightarrow 4x(x+8)-(x+8)=0$

$\Rightarrow x=\frac{1}{4},-8$

But $x \neq \frac{1}{4}$ as not satisfying given equation

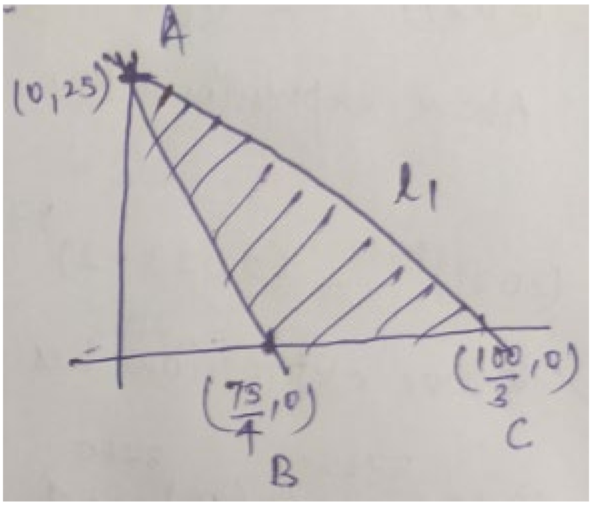
So, $x=-8$

Question: $x^2+y^2-10y-10x+41=0$ and $x^2+y^2-24x-10y+160=0$ are circles. Then the minimum distance between points lying on them is
Answer: 1.00
Solution:
$C_1(5,5)$; $r_1=3$; $C_2(12,5)$; $r_2=3$

$\therefore C_1C_2=7$

$\Rightarrow$ Minimum distance between points = $C_1C_2-r_1-r_2=1$

Question: Maximize $z=6xy+y^2$ if $3x+4y\leq 100, x, y>0$ $4x+3y\leq 75$
Answer: 625.00
Solution:



Maximize $z=6xy+y^2$

$3x+4y \le 100$

$x, y > 0$

$4x+3y \le 75$

$z(A) = (25)^2 = 625$

$z(B) = z(C) = 0$

$\therefore$ Maximum value of $z = 625$

Question:

$\overline{a} = \alpha\hat{i} + \beta\hat{j} - 3\hat{k}$

$\overline{b} = -\beta\hat{i} - \alpha\hat{j} + \hat{k}$

$\overline{c} = \hat{i} - 2\hat{j} + \hat{k}$

$\overline{a}\cdot\overline{b} = 1$ and $\overline{b}\cdot\overline{c} = -3$. Find $\frac{1}{3}(\overline{a}\times\overline{c})\cdot\overline{b}$

Answer: 2.00

Solution:

$\overline{a} = \alpha\hat{i} + \beta\hat{j} - 3\hat{k}$

$\overline{b} = -\beta\hat{i} - \alpha\hat{j} + \hat{k}$

$\overline{c} = \hat{i} - 2\hat{j} + \hat{k}$

$\overline{a}\cdot\overline{b} = 1 \Rightarrow -2\alpha\beta - 3 = 1 \Rightarrow \alpha\beta = -2$

$\overline{b}\cdot\overline{c} = -2 \Rightarrow -\beta + 2\alpha + 1 = -3 \Rightarrow 2\alpha - \beta = -4$

$\alpha = -1$

$\beta = 2$

$$\therefore \overline{a}\times\overline{c} = \begin{vmatrix} i & j & k \\ \alpha & \beta & -3 \\ 1 & -2 & 1 \end{vmatrix} = (\beta-6)\hat{i} - (\alpha+3)\hat{j} - (2\alpha+\beta)\hat{k}$$

$$\therefore \frac{1}{3}(\overline{a}\times\overline{c})\cdot\overline{b} = \frac{1}{3}\left[6\beta - \beta^2 + \alpha^2 + 3\alpha - 2\alpha - \beta\right]$$

$$= \frac{1}{3}\left[\left(\alpha^2+\alpha\right) - \left(\beta^2 - 5\alpha\right)\right] = \frac{1}{3}\left[0 - (-6)\right] = 2$$