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JEE-Main-26-08-2021-Shift-2 (Memory Based)

PHYSICS

Question: Temperature of equal masses of 3 substances A, B, C are $10°C, 20°C$ & $30°C$ respectively. When A & B are mixed, the equilibrium temperature is 16ºC. When B & C are mixed it is 26ºC. Find equilibrium temperature, when A & C are mixed.

Options:

(a) 15.2ºC
(b) 20.4ºC
(c) 23.8ºC
(d) 26.5ºC

Answer: (c)

Solution:

(A)	(B)	(C)	
10ºC	20ºC	30ºC	
S_A	S_B	S_C	(specific heat capacity)

$m_A = m_B = m_C = m$

When A and B are mixed final temperature will be 16ºC.

$\therefore$ heat gain by A = Heat lost by B.

$$mS_A(16-10) = mS_B(20-16)$$

$$S_A = \frac{2}{3}S_B \ldots (1)$$

Similarly when B and C are mixed final temperature will be 26ºC

$$\therefore mS_B(26-20) = mS_C(30-26)$$

$$S_C = \frac{3}{2}S_B \ldots (2)$$

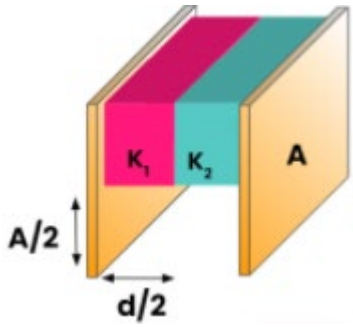
When A & C are mixed let find final temperature is T.

$$mS_A(T-10) = (30-T)mS_C$$

$$\frac{2}{3}S_B(T-10) = \frac{3}{2}S_B(30-T)$$

$$T = 23.8°C$$

Question: Find equivalent capacitance of the given setup.
(Plate area = A, Plate separation = d)



Options:

(a) $\left(\frac{k_1k_2}{k_1+k_2}+\frac{1}{2}\right)\frac{A\varepsilon_0}{d}$

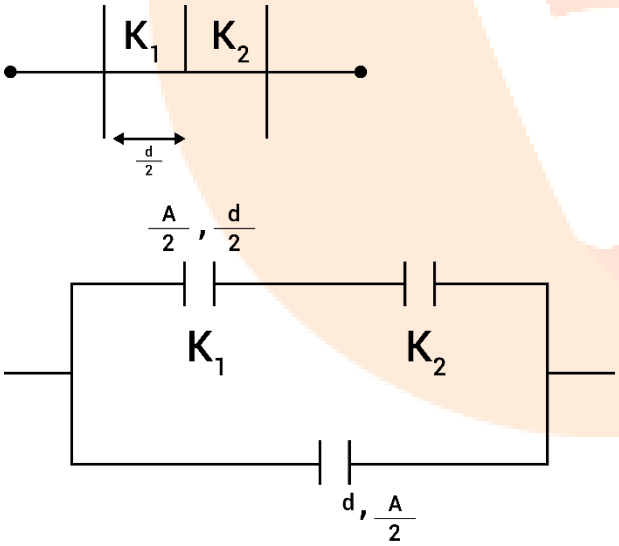
(b) $\left(\frac{k_1k_2}{k_1+k_2}+2\right)\frac{A\varepsilon_0}{d}$

(c) $\frac{2k_1k_2}{k_1+k_2}\frac{A\varepsilon_0}{d}$

(d) $\frac{k_1k_2}{2(k_1+k_2)}\frac{A\varepsilon_0}{d}$

Answer: (a)

Solution:



$$C_{eq}=\frac{\varepsilon_0\frac{A}{2}}{\frac{d}{2k_1}+\frac{d}{2k_2}}+\frac{\varepsilon_0A}{2d}$$

$$=\frac{\varepsilon_0Ak_1k_2}{d(k_1+k_2)}+\frac{\varepsilon_0A}{2d}$$

$$= \frac{\varepsilon_0 A}{d}\left(\frac{k_1 k_2}{k_1 + k_2} + \frac{1}{2}\right)$$

Question: A ball of mass M is rotating in a conical pendulum by a string of length L. If radius of circular path is $\frac{L}{\sqrt{2}}$, find the velocity of mass

Options:

(a) $\sqrt{gL}$

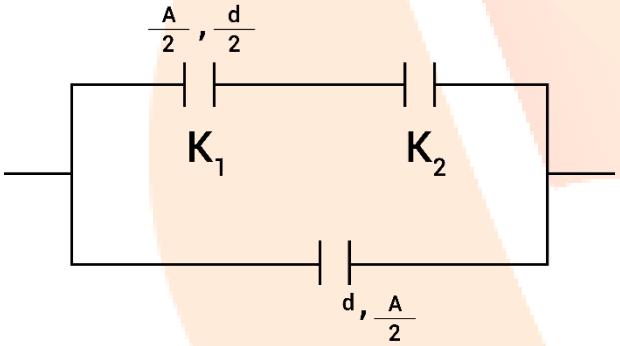
(b) $\sqrt{\frac{gL}{2}}$

(c) $\sqrt{2gL}$

(d) $\sqrt{\frac{gL}{\sqrt{2}}}$

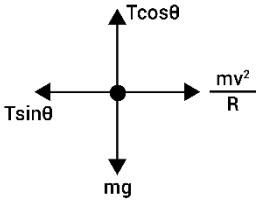
Answer: (d)

Solution:



$$R = \frac{L}{\sqrt{2}} = L\sin\theta$$

$$\therefore \theta = 45°$$



$$T\cos\theta = mg$$

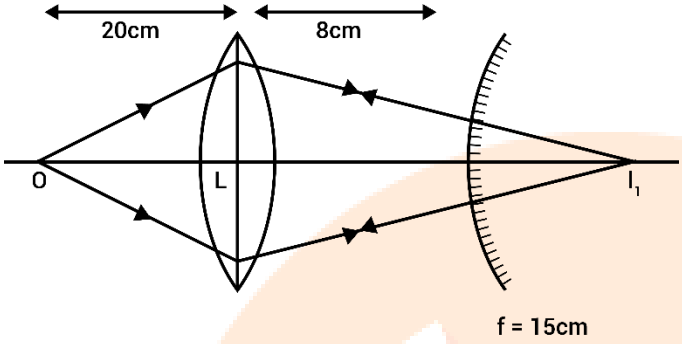
$$T\sin\theta = \frac{mv^2}{R}$$

$$\tan\theta = \frac{v^2}{Rg} \Rightarrow 1 = \frac{v^2}{Rg}$$

$v^2 = \sqrt{Rg}$

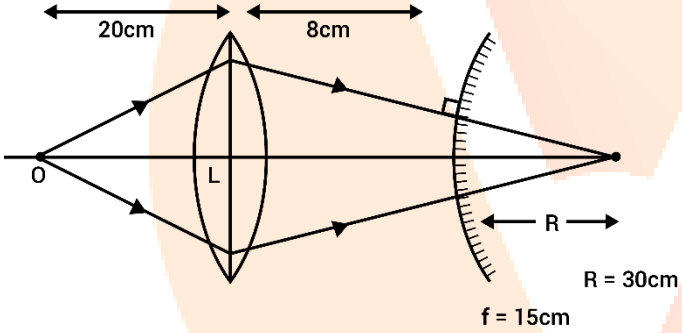
$= \sqrt{\frac{gL}{\sqrt{2}}}$

Question: The image is formed on the object itself on the given arrangement. If mirror is removed, what is the distance between the object and the image?



Answer: 58 cm

Solution:



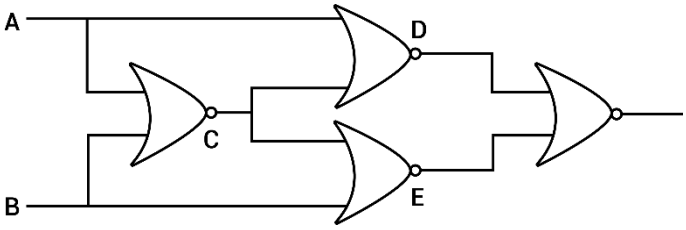
Since image is formed on the object itself therefore incident rays on the mirror are perpendicular to the mirror.

∴ they will meet at the center of curvature of the mirror.

If mirror is removed then the refracted rays from the lens will meet at a distance 38 cm.

∴ distance between object and image will be 38 + 20 = 58 cm

Question: How will the truth table look like?



Answer:

Solution:

A	B	$C=\overline{A+B}$	$D=\overline{A+C}$	$E=\overline{C+B}$	$y=\overline{D+E}$
0	0	1	0	0	1
0	1	0	1	0	0
1	0	0	0	1	0
1	1	0	0	0	1

Question: Find the maximum value of F so that there is no relative slip between the blocks?

Answer: 15 N

Solution:

Maximum acceleration of 1 kg block $=\mu g=0.5\times10$

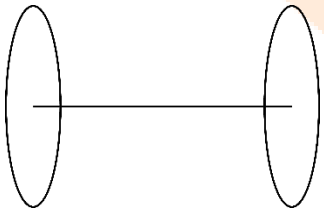
$=5m/s^2$

$\therefore$ Maximum acceleration of whole system must be $5m/s^2$

So $F=(M+m)a$

$F=3\times5=15N$

Question: The two oppositely charged rings of radii a are separated by s. Find the potential difference between center of the ring? (magnitude of charge is q)



Answer: $2kq\left(\frac{1}{a}-\frac{1}{\sqrt{a^2+s^2}}\right)$

Solution:

Potential at centre of

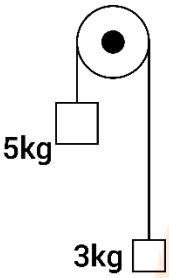
Ring 1 $=\frac{kq}{a}+\frac{k(-q)}{\sqrt{a^2+s^2}}$

$$\text{Ring 2} = \frac{kq}{\sqrt{a^2+s^2}} + \frac{k(-q)}{a}$$

$$\text{Potential difference} = \left[\frac{kq}{a} + \frac{k(-q)}{\sqrt{a^2+s^2}}\right] - \left[\frac{kq}{\sqrt{a^2+s^2}} + \frac{k(-q)}{a}\right]$$

$$= 2kq\left(\frac{1}{a} - \frac{1}{\sqrt{a^2+s^2}}\right)$$

Question: A wire is supporting two masses on a pulley as shown. If breaking stress of wire is $\frac{2400}{\pi} Nm^{-2}$. Find minimum radius of wire, so that it does not break.



Options:

(a) 6.25 cm

(b) 11 cm

(c) 9.5 cm

(d) 12.5 cm

Answer: (d)

Solution:

$5g - T = 5a$

$T - 3g = 3a$

$$\Rightarrow a = \frac{5g-3g}{5+3} = \frac{g}{4}$$

$$\Rightarrow T = 3g + \frac{3g}{4} = \frac{15g}{4}$$

$$\text{Stress} = \frac{T}{A} \Rightarrow \frac{15g}{4(\pi r^2)} = \frac{2400}{\pi}$$

$$\Rightarrow r^2 = \frac{15g}{4\times 2400}$$

$$\Rightarrow r = 12.5\,cm$$

Question: Match the dimensions of the physical quantities.

Magnetic flux	$M^1L^2T^{-2}A^{-1}$
Magnetic intensity	$L^{-1}A^1$
Intensity of magnetization	$L^{-1}A^1$
Magnetic induction	$M^1T^{-2}A^{-1}$

Solution:

$F = qVB$

$\Rightarrow B = \frac{F}{qV}$

Magnetic Induction $= \left[MLT^{-2}A^{-1}T^{-1}L^{-1}T\right]$

[B] $= \left[MT^{-2}A^{-1}\right]$

Magnetic flux = BA

$\left[\phi\right] = \left[MT^{-2}A^{-1}L^2\right]$

Magnetization $\left[I\right] = \frac{\vec{M}}{V} = \frac{AL^2}{L^3} = \left[AL^{-1}\right]$

Dimension of magnetic intensity and intensity of magnetization are same.

Question: An EM wave is propagating along X-axis, such that $\vec{E} = 800\sin\left(kx - \omega t\right)\hat{j}$. If an electron is projected with velocity $3\times10^7\, ms^{-1}$. Along Y-axis, then the maximum magnetic force experienced by electron is

Options:

(a) $1.28\times10^{-17}\, N$

(b) $2.4\times10^{-16}\, N$

(c) $3.2\times10^{-18}\, N$

(d) None

Answer: (a)

Solution:

$E_0 = CB_0$

$\Rightarrow B_0 = \frac{E_0}{C}$

$\vec{F}_{max} = qVB_0$

$= qV\frac{E_0}{C} = \frac{1.6\times10^{-19}\times3\times10^7\times800}{3\times10^8}$

$= 1.28 \times 10^{-17} N$

Question: Transmitter antenna height = 50 m, receiver antenna height = 80 m, radius of earth = 6400 km. Find the maximum distance between them for L.O.S. communication?

Answer: $57.3\,km$

Solution:

$h_T = 50\,cm$

$h_R = 80\,m$

$R_E = 6.4 \times 10^6\,m$

For L.O.S. communication

$d_{\max} = \sqrt{2h_T R_E} + \sqrt{2h_R R_E}$

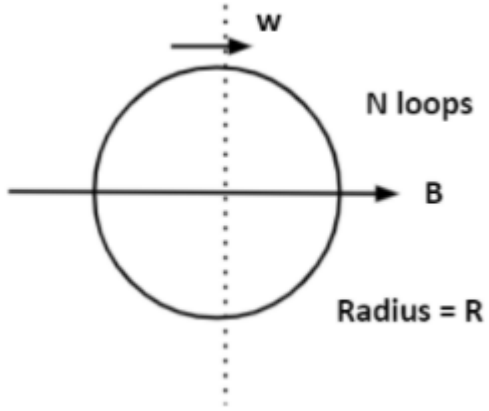
$= \sqrt{2 \times 50 \times 6.4 \times 10^6} + \sqrt{2 \times 80 \times 6.4 \times 10^6}$

$= 10\sqrt[4]{6.4} + 4 \times 8 \times 10^3$

$= 8\left(4 + \sqrt{10}\right) \times 10^3 M$

$= 57.3\,km$

Question: Find the maximum induced emf?



Answer: $\pi R^2 Bwn$

Solution:

At any time t

Angle rotated $\theta = \omega t$

Flux $(\phi) = nBA\cos\theta$

$= nBa\cos(\omega t)$

Induced emf $= -\frac{d\phi}{dt} = -nBA\omega\sin(\omega t)$

Maximum value of emf $= nBA\omega$

$= nB\pi R^2\omega$

Question: $x_1 = \frac{5}{2}\left[\sin(2\pi t) + \cos(2\pi t)\right]$, $x_2 = 5\left[\sin\left(2\pi t + \frac{\pi}{4}\right)\right]$

Find ratio of amplitude of the given motion?

Options:

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

(b) $2:1$

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

(d) $1:2$

Answer: (c)

Solution:

$x_1 = \frac{5}{2}\left[\sin(2\pi t) + \cos(2\pi t)\right]$

$x_2 = 5\left[\sin\left(2\pi t + \frac{\pi}{4}\right)\right]$

Resultant amplitude of first motion

$A_1 = \frac{5}{2}\sqrt{1^2 + 1^2} = \frac{5\sqrt{2}}{2}$

Amplitude of second motion

$A_2 = 5$

Ratio $\frac{A_1}{A_2} = \frac{5\sqrt{2}}{2\times 5} = \frac{1}{\sqrt{2}}$

Question: A cylinder of height L, mass M & Radius $\frac{L}{\sqrt{2}}$ has MOI 1.2 kg m^2 about an axis at a distance L/2 parallel to axis of cylinder. If length of cylinder is 80 cm, find the density of cylinder.

Options:

(a) 5.3 kg m^{-3}

(b) 4.6 kg m^{-3}

(c) 10.23 kg m^{-3}

(d) None

Answer: (b)

Solution:

MOI of cylinder about an axis at L/2 distance from the axis of cylinder

$$I' = I_{COM} + Md^2$$

$$1.2 = \frac{MR^2}{2} + \frac{ML^2}{4}$$

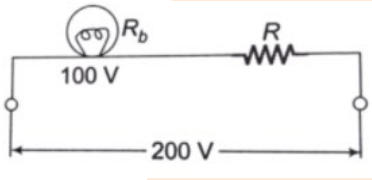
$$1.2 = \frac{ML^2}{4} + \frac{ML^2}{4} = \frac{ML^2}{2}$$

$$\Rightarrow M = \frac{2.4}{L^2} = \frac{2.4}{64 \times 10^{-2}} = 3.75\,kg$$

$$\rho = \frac{M}{V} = \frac{3.75}{\pi \times \frac{L^2}{2} \times L} = \frac{7.5}{\pi L^3} = 4.66\,kg\,m^{-3}$$

Question: A bulb with rating 100V, 500W is to be connected in series with an unknown resistance and a battery of 200 Volts.

What must be the value of this unknown resistance, such that the bulb still dissipates 500 W.



Options:

(a) $25\,\Omega$

(b) $50\,\Omega$

(c) $20\,\Omega$

(d) $10\,\Omega$

Answer: (a)

Solution:

$$R_b = \frac{100 \times 100}{500} = 20\,\Omega$$

For bulb to consume 500 W power, voltage drop at bulb should be equal to 100 V.

i.e. unknown resistance should also have voltage drop of 100 V.

This is possible when

$$R = R_b = 20\,\Omega$$

Question: Find the amplitude of the resultant wave formed by the two waves given as

$$y_1 = 5\sin(\omega t - kx),\ y_2 = 12\sin\left(\omega t - kx + \frac{2\pi}{3}\right)$$

Options:

(a) $\sqrt{109}$

(b) $\sqrt{100}$
(c) $\sqrt{169}$
(d) $\sqrt{196}$
Answer: (a)
Solution:

Phase difference $\phi = \frac{2\pi}{3}$

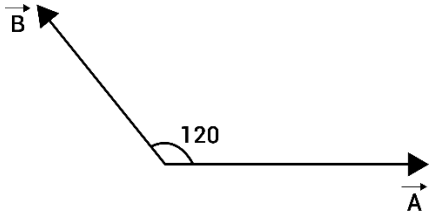
$$A = \sqrt{A_1^2 + A_2^2 + 2A_1A_2\cos\phi}$$
$$A = \sqrt{5^2 + 12^2 + 2\times5\times12\times\cos\left(\frac{2\pi}{3}\right)}$$
$$A = \sqrt{25+144-60}$$
$$A = \sqrt{109}$$

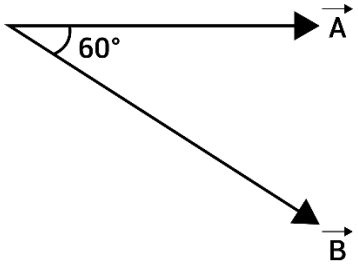
Question: For a second's pendulum how much will the measured value of the time of a day differ by if length increases by 0.1 cm?
Answer: 43.2 s
Solution:

$$T = 2\pi\sqrt{\frac{l}{g}}$$
$$\therefore \frac{\Delta T}{T} = \frac{1}{2}\frac{\Delta L}{l}$$
$$\therefore \frac{\Delta T}{86400} = \frac{1}{2}\frac{10^{-3}}{1}$$
$$\therefore \Delta T = 43.2\,s$$

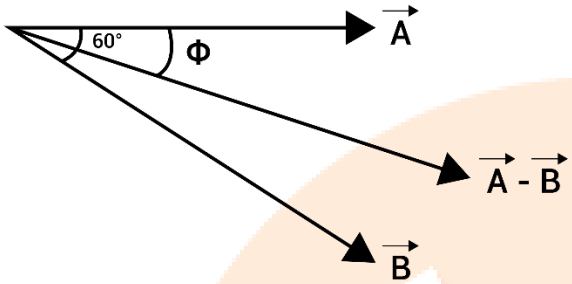
Question: Two vectors $\vec{A}$ & $\vec{B}$ having same magnitude are at an angle 120° with each other. Find the angle between $\vec{A}$ & $\vec{A}-\vec{B}$
Options:
(a) 120°
(b) 30°
(c) 60°
(d) 45°
Answer: (b)
Solution:

$|\vec{A}| = |\vec{B}| \quad \theta = 120°$





$\vec{A} - \vec{B} = \vec{A} + (-\vec{B})$



$$\tan\phi = \frac{B\sin\theta}{A + B\cos\theta} = \frac{A\sin 60}{A + A\cos 60}$$

$$\tan\phi = \frac{\frac{A\sqrt{3}}{2}}{A + \frac{A}{2}} = \frac{1}{\sqrt{3}}$$

$$\phi = 30°$$

Question: An unpolarised light of Intensity I0 is incident on two polaroids placed co-axially such that $\frac{I_0}{2}$ intensity is received on screen. By what angle the polaroid placed close to screen should be rotated so that intensity on screen becomes $\frac{3}{8}I_0$

Options:

(a) 30°

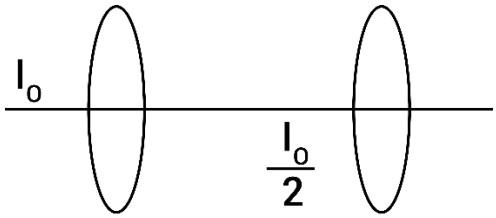
(b) 60°

(c) 45°

(d) 90°

Answer: (a)

Solution:



$\frac{I_0}{2}\cos^2\theta = \frac{I_0}{2}$

$\theta = 0°$

So, angle was 0°

If it will be rotated by θ

$\frac{I_0}{2}\cos^2\theta = \frac{3I_0}{8} \Rightarrow \cos^2\theta = \frac{3}{4} \Rightarrow \theta = 30°$

Question: The debroglie wavelength of an electron is λ & has energy E. If the debroglie wavelength is reduced by 25%, then how much extra kinetic energy will the electron have now?

Options:

(a) $\frac{16}{9}E$

(b) $\frac{7}{9}E$

(c) $\frac{9}{7}E$

(d) $\frac{9}{16}E$

Answer: (b)

Solution:

As $\lambda = \frac{h}{\sqrt{2mE}}$

$E = \frac{h^2}{2m\lambda^2}$

New $E' = \frac{h^2}{2m(0.75\lambda)^2}$

Extra kinetic energy $= E' - E$

$= \frac{h^2}{2m(0.75\lambda)^2} - \frac{h^2}{2m\lambda^2}$

$= \frac{h^2 - 0.56h^2}{2m\lambda^2(0.5625)}$

$= \frac{0.43}{0.56}\frac{h^2}{2m\lambda^2}$

$= 0.77E$

Hence (b) $\frac{7}{9}E$ is correct

Question: A container has 1 mole of some gas and 2 mole of other gas has volume $1m^3$ at 27°C. Find the pressure of the gas in kPa?

Answer: (7.4 Kp_a)

Solution:

Using $PV = nRT$

$$P_1 = \frac{nRT_1}{V} = \frac{1 \times R \times 300}{1}$$

$$P_2 = \frac{2 \times R \times 300}{1}$$

Using Mixture law, $P = P_1 + P_2$

$$= 3 \times R \times 300$$
$$= 3 \times 8.31 \times 300$$
$$= 7479\, Pa$$
$$= 7.4\, kPa$$

Question: In a refrigerator, temperature inside is -10°C and room temperature is 25°C. If electrical input power is 35 watts. At what rate is the heat rejected?

Answer: (298 watts)

Solution:

$$\text{Coefficient of Performance} = \frac{\text{Heat Rejected}}{\text{Work done}}$$

$$T_0 + 273 + 25 = 298K$$
$$T_{\text{refrigerator}} = 273 - 10 = 263K$$

$$\frac{\text{Heat Rejected}}{\text{Work done}} = \frac{T_0}{T_0 - T_{\text{refrigerator}}}$$

$$= \left(\frac{298}{298 - 263}\right)^{35}$$

Heat Rejected = 298 w

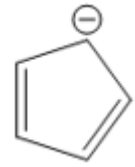
JEE-Main-26-08-2021-Shift-2 (Memory Based)

CHEMISTRY

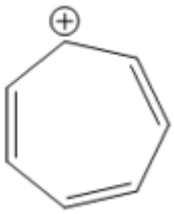
Question: Which of the following is not aromatic?

Options:

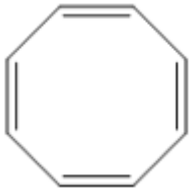
(a)



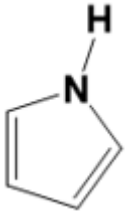
(b)



(c)

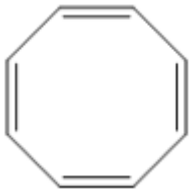


(d)



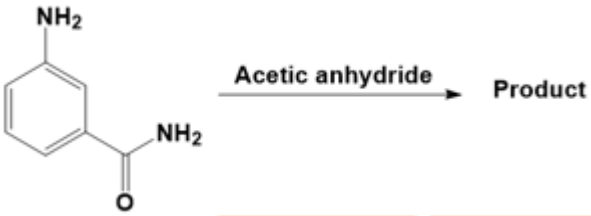
Answer: (c)

Solution:



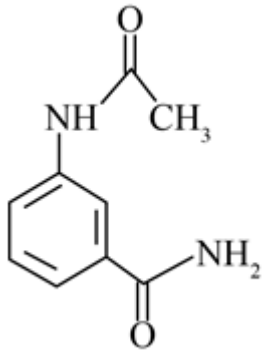
It follows 4nπ electrons rule, as it has 8π electrons
So, it is nonaromatic in nature due to tub shaped form
Rest other follows (4n + 2)π electrons rule
Hence, are aromatic in nature

Question:

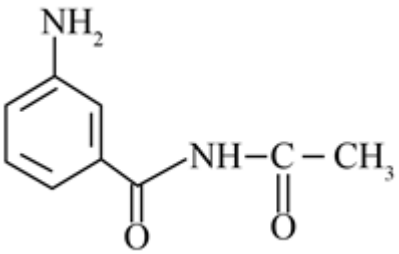


Options:

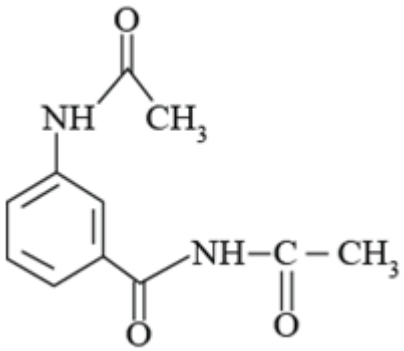
(a)



(b)



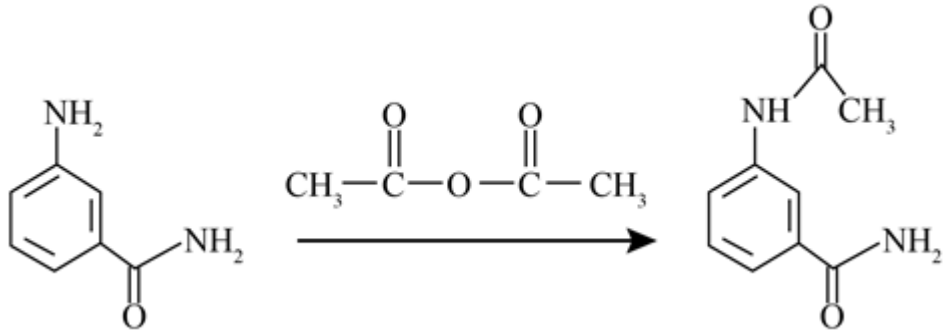
(c)



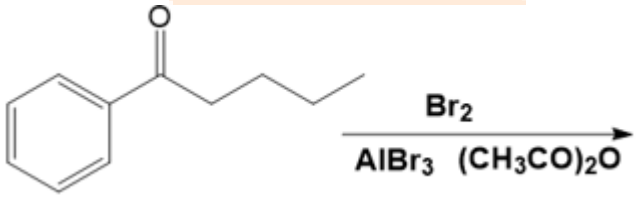
(d) No reaction

Answer: (a)

Solution:

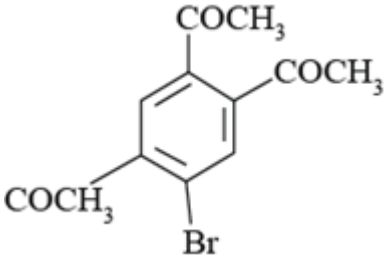


Question:

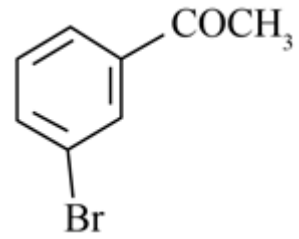


Options:

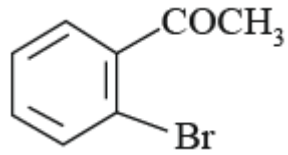
(a)



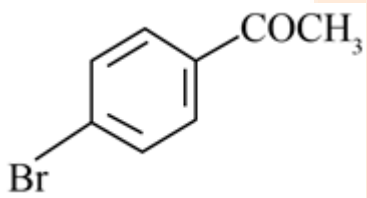
(b)



(c)

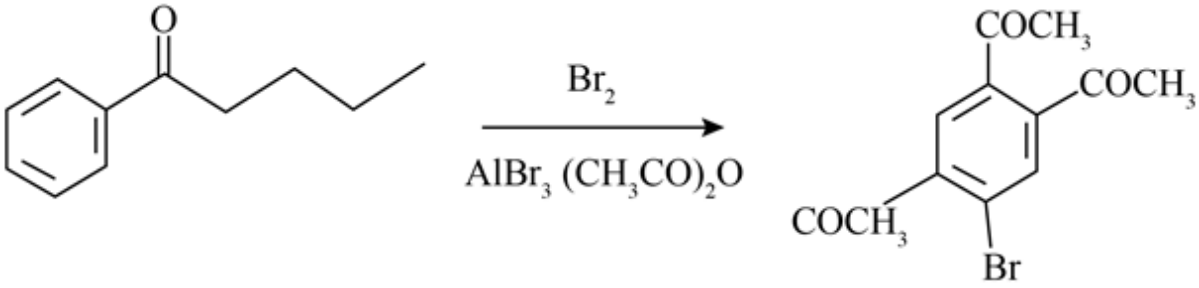


(d)



Answer: (a)

Solution:



Question: Which of the following is a negative sol?

Options:

(a) $AgNO_3$ in KI solution

(b) KI in $AgNO_3$ solution

(c) AgI in contact with $AgNO_3$

(d) $Fe(OH)_3$ in $FeCl_3$ solution

Answer: (a)

Solution: AgI will form and the common ion I^- will be adsorbed which makes sol negative

Question: What is the number of non-ionizable hydrogen in the compound formed upon hydrolysis of PCl_5?

Options:

(a) 3

(b) 0

(c) 2

(d) 1

Answer: (b)

Solution: PCl_5 on hydrolysis produces H_3PO_4 which has zero non-ionisable hydrogen. All hydrogen atoms are ionizable in H_3PO_4.

Question: The set of elements known as chalcogens is:

Options:

(a) O, S, Se, Te

(b) S, Cl, Br

(c) S, O, P, Mo

(d) Na, Br, Cl, I

Answer: (a)

Solution: Group 16 elements are known as chalcogens

Question: A solution contains 83g of ethylene glycol and 625 g water, find the freezing point. $K_f = 1.86$ K Kg mol^{-1}

Options:

(a) 269 K

(b) 277 K

(c) 273 K

(d) 265 K

Answer: (a)

Solution: moles of ethylene glycol = $\frac{83}{62}$

$$\text{molality} = \frac{\frac{83}{62}}{\frac{625}{1000}} = \frac{83}{62} \times \frac{1000}{625}$$

Thus,

$\Delta T_f = K_f \cdot m$

$$= 1.86 \times \frac{83}{62} \times \frac{1000}{625} = 3.984$$

Thus, $T_f = 273 - 3.984 = 269.016$ K

Question: The number of stereoisomers of the given structure

Options:

(a) 5

(b) 2

(c) 3

(d) 4

Answer: (c)

Solution: 1,2-Dimethylcyclopropane is a cycloalkane consisting of a cyclopropane ring substituted with two methyl groups attached to adjacent carbon atoms. It has three stereoisomers, one cis-isomer and a pair of trans-enantiomers, which differ depending on the orientation of the two methyl groups.

Question: A + B ⇌ C + D. Initially all are 1 M. $K_C = 100$. Find the final concentration of D

Options:

(a) 9/11

(b) 20/11

(c) 2/11

(d) 11/20

Answer: (b)

Solution: Here, $Q = \frac{[C][D]}{[A][B]} = 1$

Thus, reaction will proceed in forward reaction

$$A + B \rightleftharpoons C + D$$

Initial $1 \quad 1 \quad 1 \quad 1$

Final $1-x \quad 1-x \quad 1+x \quad 1+x$

$$k_c = \frac{(1+x)^2}{(1-x)^2} \Rightarrow 100 = \frac{(1+x)^2}{(1-x)^2}$$

$$\Rightarrow \frac{1+x}{1-x} = 10$$

$$\Rightarrow 1+x = 10-10x$$

$$\Rightarrow 11x = 9$$

$$\Rightarrow x = \frac{9}{11}$$

$$\therefore [D] = 1+x = 1+\frac{9}{11} = \frac{20}{11}$$

Question: Peroxide (O_2^{2-}) and superoxide ions (O_2^-) are, respectively:

Options:

(a) Diamagnetic and diamagnetic

(b) Paramagnetic and paramagnetic

(c) Paramagnetic and diamagnetic

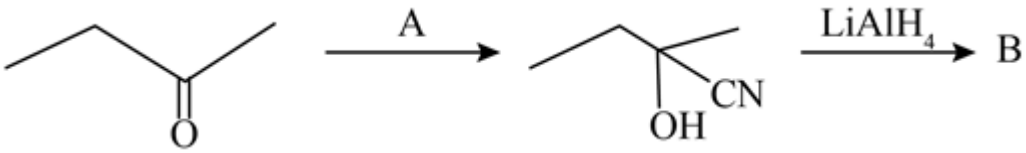
(d) Diamagnetic and paramagnetic

Answer: (d)

Solution: Peroxide ion (O_2^{2-}) does not have any unpaired electrons and is diamagnetic

The superoxide ion (O_2^-) will have one unpaired electron and therefore will be paramagnetic

Question:



Options:

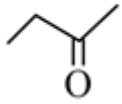
(a)

A = KCN

B = 

(b)

A = KCN

B = 

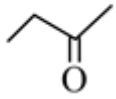
(c)

A = PCC

B = 

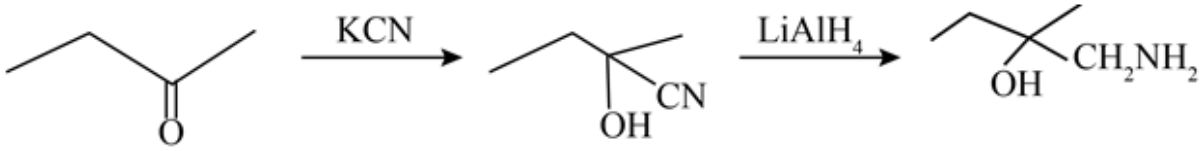
(d)

A = PCC

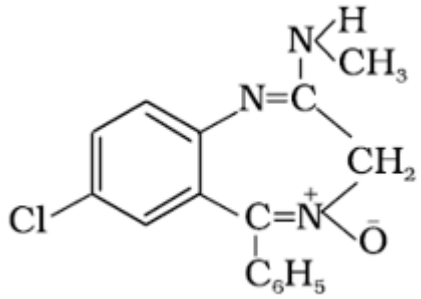
B = 

Answer: (a)

Solution:



Question: Chlordiazepoxide



is a :

Options:

(a) Analgesic

(b) Antipyretics

(c) Tranquilizer

(d) Antibiotics

Answer: (c)

Solution: Tranquilizer, drug that is used to reduce anxiety, fear, tension, agitation, and related states of mental disturbance. Tranquilizer fall into two main classes, major and minor. For example - chlordiazepoxide

Question: $[CoF_6]^{3-}$; $[Co(H_2O)_6]^{3+}$; $[Co(NH_3)_6]^{3+}$; $[Co(en)_3]^{3+}$. What is the order of CFSE?

Options:

(a) $[CoF_6]^{3-} < [Co(H_2O)_6]^{3+} < [Co(NH_3)_6]^{3+} < [Co(en)_3]^{3+}$

(b) $[Co(en)_3]^{3+} < [Co(NH_3)_6]^{3+} < [Co(H_2O)_6]^{3+} < [CoF_6]^{3-}$

(c) $[Co(H_2O)_6]^{3+} < [CoF_6]^{3-} < [Co(NH_3)_6]^{3+} < [Co(en)_3]^{3+}$

(d) $[Co(NH_3)_6]^{3+} < [CoF_6]^{3-} < [Co(H_2O)_6]^{3+} < [Co(en)_3]^{3+}$

Answer: (a)

Solution: For the same central metal ion, the CFSE increases with increase in strength of the ligand. The order of strength is given by spectrochemical series:

$I^- < Br^- < SCN^- < Cl^- < S^{2-} < F^- < OH^- < C_2O_4^{2-} < H_2O < NCS^- < edta^{4-} < NH_3 < en < CN^- < CO$

Thus, the order of CFSE of given complexes will be $[CoF_6]^{3-} < [Co(H_2O)_6]^{3+} < [Co(NH_3)_6]^{3+} < [Co(en)_3]^{3+}$

Question: S1: Heavy water is used in exchange reactions for the study of reaction mechanisms.

S2: Heavy water has more density than H_2O.

Options:

(a) Both S1 and S2 are correct.

(b) S1 is correct but S2 is incorrect.

(c) S1 is incorrect but S2 is correct.

(d) Both S1 and S2 are incorrect.

Answer: (a)

Solution: Sl: Heavy water is extensively used as a moderator in nuclear reactors and in exchange reactions for the study of reaction mechanisms.

S2: Density (298K)/g cm^{-3}:

Water 1.0000

Heavy water: 1.1059

Question: S1: Sucrose is a non-reducing sugar

S2: In sucrose, glycosidic linkage is between C1 of β-D glucose and C2 of α-D glucose.

Options:

(a) Both S1 and S2 are correct.

(b) S1 is correct but S2 is incorrect.

(c) S1 is incorrect but S2 is correct.

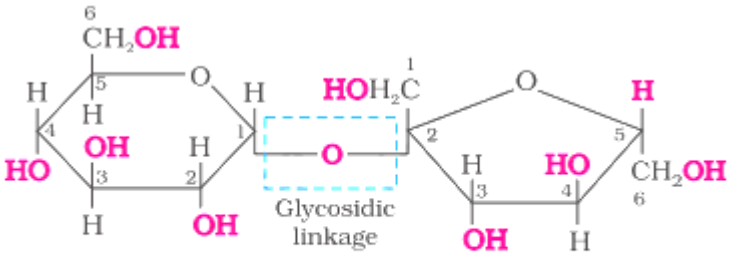
(d) Both S1 and S2 are incorrect.

Answer: (b)

Solution: Sucrose: One of the common disaccharides is sucrose which on hydrolysis gym equimolar mixture of D-(+)-glucose and D-(-) fructose.

$$\underset{\text{Sucrose}}{C_{12}H_{22}O_{11}} + H_2O \rightarrow \underset{\text{D-(+)-Glucose}}{C_6H_{12}O_6} + \underset{\text{D-(−)-Fructose}}{C_6H_{12}O_6}$$

These two monosaccharides are held together by a glycosidic linkage between Cl of α-D-glucose and C2 of β-D-fructose. Since the reducing groups of glucose and fructose are involved in glycoside bond formation sucrose is a non-reducing sugar.



α – D – Glucose β – D – Fructose

Sucrose

Question: S1: Sphalerite and copper glance are the sulphide ores of Zinc and Copper

S2: it is possible to separate two sulphide ores by adjusting proportion of oil to water or by using 'depressants'.

Options:

(a) Both S1 and S2 are correct.

(b) S1 is correct but S2 is incorrect.

(c) S1 is incorrect but S2 is correct.

(d) Both S1 and S2 are incorrect.

Answer: (a)

Solution: ZnS ⇒ Zinc blende or Sphalerite

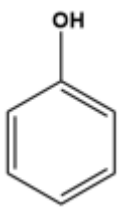
Cu_2S ⇒ Copper glance or Chalcocite

Sometimes, it is possible to separate two sulphide ores by adjusting proportion of oil to water or by using depressants. For example, in case of an ore containing ZnS and PbS, the depressant used is NaCN. It selectively prevents ZnS from coming to the froth but allows PbS to come with the froth.

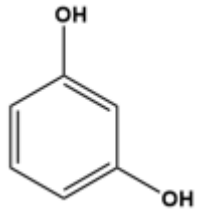
Question: Which will not react with phthalic anhydride?

Options:

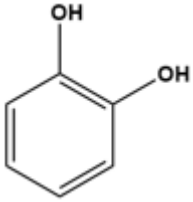
(a)



(b)



(c)



(d) All of these

Answer: (d)

Solution: Ortho will not react with phthalic anhydride, as it will form intermolecular hydrogen bonding.

Question: Zn | Zn^{2+} (0.02 M) | | Cu^{2+} (0.04 M) | Cu

$E^{\circ}_{Zn|Zn^{2+}} = 0.76,\ E^{\circ}_{Cu|Cu^{2+}} = -0.34$

Find E_{cell}. $\left(\text{use}\ \frac{2.303RT}{F} = 0.059\right)$

Answer: 1.11

Solution:

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

$E^{\circ}_{cell} = 0.34 - (-0.76) = 1.1\ V$

$$E_{cell} = E^{\circ}_{cell} - \frac{0.059}{2}\log\frac{\left[Zn^{2+}\right]}{\left[Cu^{2+}\right]}$$

$$E_{cell} = 1.1 - \frac{0.059}{2}\log\frac{1}{2}$$

$$E_{cell} = 1.1 + \frac{0.059}{2}\log 2$$

$$E_{cell} = 1.1 + 0.0088795$$

$$E_{cell} = 1.1088795 \approx 1.11\ V$$

JEE-Main-26-08-2021-Shift-2 (Memory Based)

MATHEMATICS

Question: $2\sin\frac{\pi}{8}\sin\frac{2\pi}{8}\sin\frac{3\pi}{8}\sin\frac{5\pi}{8}\sin\frac{6\pi}{8}\sin\frac{7\pi}{8}=?$

Options:

(a)

(b)

(c)

(d)

Answer: $\frac{1}{8}$

Solution:

$$=\sin^2\frac{\pi}{8}\cdot\sin^2\frac{3\pi}{8}$$

$$=\frac{\left(1-\cos\frac{\pi}{4}\right)\left(1-\cos\frac{3\pi}{4}\right)}{4}$$

$$=\frac{\left(\sqrt{2}-1\right)\left(\sqrt{2}+1\right)}{8}=\frac{1}{8}$$

Question: $\int_{\frac{-\pi}{2}}^{\frac{\pi}{2}}\frac{1+\sin^2 x}{1+\pi^{\sin x}}dx=?$

Options:

(a)

(b)

(c)

(d)

Answer: $\frac{3\pi}{4}$

Solution:

$$I=\int_{-\frac{\pi}{2}}^{\frac{\pi}{2}}\frac{1+\sin^2 x}{1+\pi^{\sin x}}dx \qquad ....(1)$$

$$\int_a^b f(x)\,dx = \int_a^b f(a+b-x)\,dx$$

$$I = \int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} \frac{1+\sin^2 x}{1+\pi^{-\sin x}}\,dx \qquad ....(2)$$

(1) + (2)

$$I = \int_0^{\frac{\pi}{2}} \left(1+\sin^2 x\right)dx$$

$$I = \frac{\pi}{2} + \frac{\pi}{4} = \frac{3\pi}{4}$$

Question: $\left(\sqrt{3}+i\right)^{100} = 2^{99}\left(p+iq\right)$ then p and q are roots of which of the following equation ?

Options:

(a) $x^2 - \left(\sqrt{3}+1\right)x - \sqrt{3} = 0$

(b) $x^2 - \left(\sqrt{3}-1\right)x - \sqrt{3} = 0$

(c)

(d)

Answer: (b)

Solution:

$$\left(\sqrt{3}+i\right)^{100} = 2^{99}\left(p+iq\right)$$

$$\left(\frac{\sqrt{3}+i}{2}\right)^{100} = \frac{p+iq}{2}$$

$$\frac{1}{i^{100}}\left(\frac{-1+\sqrt{3}i}{2}\right)^{100} = \frac{p+iq}{2}$$

$$\Rightarrow \omega^{100} = \frac{p+iq}{2}$$

$$\Rightarrow \omega = \frac{p+iq}{2}$$

$$\Rightarrow \frac{-1+\sqrt{3}i}{2} = \frac{p+iq}{2}$$

$\Rightarrow p=-1, q=\sqrt{3}$

p & q are roots of $x^2-\left(\sqrt{3}-1\right)x-\sqrt{3}=0$

$x^2-\left(\sqrt{3}-1\right)x-\sqrt{3}=0$

Question: $\begin{bmatrix}1 & 0 & 0\\ 0 & 1 & 1\\ 1 & 0 & 0\end{bmatrix}=A$, then $A^{2025}-A^{2020}$

Options:

(a) A^5

(b) A^6

(c) A^6-A

(d) A^5-A

Answer: (c)

Solution:

$$A=\begin{bmatrix}1 & 0 & 0\\ 0 & 1 & 1\\ 1 & 0 & 0\end{bmatrix}$$

$$A^2=\begin{bmatrix}1 & 0 & 0\\ 0 & 1 & 1\\ 1 & 0 & 0\end{bmatrix}\begin{bmatrix}1 & 0 & 0\\ 0 & 1 & 1\\ 1 & 0 & 0\end{bmatrix}$$

$$=\begin{bmatrix}1 & 0 & 0\\ 1 & 1 & 1\\ 1 & 0 & 0\end{bmatrix}$$

$$A^3=\begin{bmatrix}1 & 0 & 0\\ 1 & 1 & 1\\ 1 & 0 & 0\end{bmatrix}\begin{bmatrix}1 & 0 & 0\\ 0 & 1 & 1\\ 1 & 0 & 0\end{bmatrix}$$

$$=\begin{bmatrix}1 & 0 & 0\\ 2 & 1 & 1\\ 1 & 0 & 0\end{bmatrix}$$

$\therefore A^{2025}-A^{2020}=$

$$\begin{bmatrix} 1 & 0 & 0 \\ 2024 & 1 & 1 \\ 1 & 0 & 0 \end{bmatrix} - \begin{bmatrix} 1 & 0 & 0 \\ 2019 & 1 & 1 \\ 1 & 0 & 0 \end{bmatrix}$$

$$= \begin{bmatrix} 0 & 0 & 0 \\ 5 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix} = A^6 - A$$

Question: α, β are roots of $x^2 - x - \lambda = 0$ and α, γ are roots of $3x^2 - 10x + 27\lambda = 0$. Find the value of $\frac{\beta\gamma}{\lambda}$

Solution:

$x^2 - x - \lambda = 0 \rightarrow \alpha, \beta$

$3x^2 - 10x + 27\lambda = 0 \rightarrow \alpha, \gamma$

$\because$ α is common root

$\therefore -7\alpha + 30\lambda = 0$

$\alpha = \frac{30\lambda}{7}$

$\therefore \frac{900\lambda^2}{49} - \frac{37\lambda}{7} = 0$

$\lambda = \frac{37 \times 7}{900} = \frac{259}{900}$

$\alpha\beta = -\lambda \Rightarrow \beta = \frac{-\lambda}{\alpha}$

$\alpha\gamma = 9\lambda \Rightarrow \gamma = \frac{9\lambda}{\alpha}$

$\therefore \frac{\beta\gamma}{\lambda} = \frac{-9\lambda}{\alpha^2} = \frac{-9 \times 7}{900\lambda^2}$

$= \frac{-9}{37}$

Question: $f(x)=\left(\frac{2}{x}\right)^{x^2}$. Find minimum value of $f(x)$

Options:

(a)

(b)

(c)

(d)

Answer: ()

Solution:

$$y=\left(\frac{2}{x}\right)x^2$$

$$\ln y = x^2\left[\ln 2-\ln x\right]$$

$$y'=y\left[\ln\left(\frac{2}{x}\right)\cdot 2x-x\right]$$

$$y'=0\Rightarrow \ln\frac{4}{x^2}=1$$

$$x^2=\frac{4}{e}\Rightarrow x=\pm\frac{2}{\sqrt{e}}$$

$$\therefore y_{\min}=\left(\sqrt{e}\right)^{\frac{4}{e}}=e^{\frac{2}{e}}$$

Question: $\lim\limits_{x\to 2}\sum\limits_{n=1}^{9}\frac{x}{n(n+1)x^2+2(2n+1)x+4}$

Answer: $\frac{9}{44}$

Solution:

$$\sum_{n=1}^{9}\frac{x}{\left(n^2x^2+4nx+4\right)+x(nx+2)}$$

$$=\sum_{n=1}^{9}\frac{x}{(nx+2)^2+x(nx+2)}$$

$$=\sum_{n=1}^{9}\frac{x}{(nx+2)(nx+x+2)}$$

$$=\sum_{n=1}^{9}\frac{(nx+x+2)-(nx+2)}{(nx+2)(nx+x+2)}$$

$$=\sum_{n=1}^{9}\frac{1}{(nx+2)}-\frac{1}{(nx+x+2)}$$

$$=\frac{1}{x+2}-\frac{1}{2x+2}+\frac{1}{2x+2}-\frac{1}{3x+2}+\ldots$$

$$=\frac{1}{x+2}-\frac{1}{10x+2}$$

$$f(x)=\frac{9x}{(x+2)(10x+2)}$$

$$\therefore \lim_{x\to 2} f(x)=\frac{18}{4\times 22}$$

$$=\frac{9}{44}$$

Question: If the line $x=2y$ touch circle C at $(2,1)$ and C cuts $C_1: x^2+y^2+2y-5=0$ such that common chord is diameter of C_1. Find diameter of C.

Answer:

Solution:

$x=2y$ touch circle at (2, 1)

Equation of circle

$$\Rightarrow (x-2)^2+(y-1)^2+\lambda(x-2y)=0$$

$$\Rightarrow x^2-2x+4+y^2-2y+1+\lambda x-2\lambda y=0$$

$$\Rightarrow x^2+y^2+x(\lambda-2)+y(-2-2\lambda)+5=0$$

Common chord with C_1 is

$$\Rightarrow x(\lambda-2)+y(-4-2\lambda)+10=0$$

It passes through (0, -1)

$$\Rightarrow 0(\lambda-2)-1(-4-2\lambda)+10=0$$

$$\Rightarrow 4+2\lambda+10=0$$

$$\Rightarrow \lambda=-7$$

$\Rightarrow$ Equation of circle is

$$\Rightarrow x^2+y^2-9x+12y+5=0$$

$$r=\sqrt{\left(\frac{9}{2}\right)^2+6^2-5}$$

$$=\sqrt{\frac{81}{4}+36-5}$$

$$=\sqrt{\frac{81}{4}+31}=\sqrt{\frac{81+124}{4}}$$

$$=\sqrt{\frac{205}{4}}$$

$$d=\sqrt{205}$$

Question: Find locus of mid point of chord of $x^2-y^2=4$ such that this chord touched $y^2=8x$.

Options:

(a)

(b)

(c)

(d)

Answer: ()

Solution:

Let mid point be (h, k)

Chord is $T=S_1$

$$x^2-y^2-4=0$$

$$\Rightarrow hx-ky-4=h^2-k^2-4$$

$$\Rightarrow hx-ky=h^2-k^2$$

$$\Rightarrow ky=hx-h^2+k^2$$

$$\Rightarrow y=\frac{h}{k}x+\frac{\left(k^2-h^2\right)}{k}$$

Above line is tangent to $y^2=8x$

$$\Rightarrow c=\frac{2}{m}$$

$$\Rightarrow \frac{k^2-h^2}{k}=\frac{2}{\frac{h}{k}}$$

$$\Rightarrow h\left(k^2-h^2\right)=2k^2$$

$$\Rightarrow x\left(y^2-x^2\right)=2y^2$$

Question: $\sum_{r=1}^{9}\tan^{-1}\left(\frac{1}{2r^2}\right)=$

Options:

(a)

(b)

(c)

(d)

Answer: ()

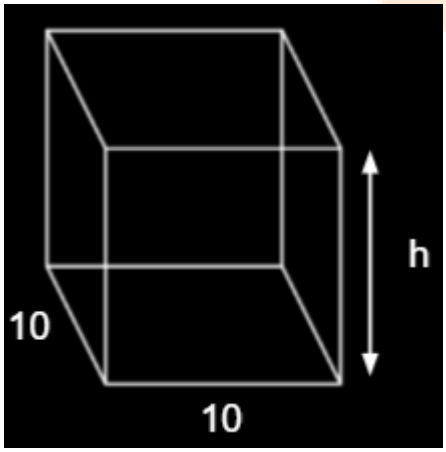
Solution:

$$\tan^{-1}\left(\frac{2}{4r^2}\right)=\tan^{-1}\left[\frac{(2r+1)-(2r-1)}{1+(2r+1)(2r-1)}\right]$$

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

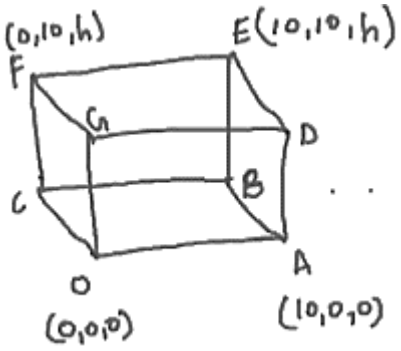
$$\therefore \sum_{r=1}^{9}\tan^{-1}\left(\frac{1}{2r^2}\right)=\tan^{-1}(19)-\frac{\pi}{4}$$

Question: Angle between two body diagonal is $\cos^{-1}\left(\frac{1}{5}\right)$. Find h.



Answer: ()

Solution:



Let $\vec{a} = \overrightarrow{OE} = 10\hat{i} + 10\hat{j} + h\hat{k}$

$\vec{b} = \overrightarrow{AF} = -10\hat{i} + 10\hat{j} + h\hat{k}$

$\therefore \cos\theta = \dfrac{\vec{a} \cdot \vec{b}}{|\vec{a}||\vec{b}|}$

$\dfrac{1}{5} = \dfrac{h^2}{\sqrt{200 + h^2}}$

$24h^2 = 200$

$h^2 = \dfrac{200}{24} = \dfrac{25}{3}$

$\therefore h = \dfrac{5}{\sqrt{3}}$

Question: Minimum value of 'n' for which $\dfrac{(2!)^n}{(1+i)^{n-2}}$ is positive integer.

Answer: 6

Solution:

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

$$= \frac{2^n \cdot i^n \cdot (1-i)^n}{(1-i)^2 (2)^{n-2}}$$

$$= \frac{4i^n (1-i)^n}{-2i}$$

$$=\frac{4(1+i)^n}{-2i}$$

$$(1+i)^2=2i$$

$$(1+i)^4=-4$$

$$(1+i)^6=-8i$$

Hence for $n=6$ given expression will become $\frac{4(-8i)}{-2i}=16$

Question: $\int_0^5 \frac{x+[x]}{e^{n-[x]}}=\alpha e^{-1}+\beta$, then $(\alpha+\beta)^2=?$

Answer: 25

Solution:

$$\int_0^1 \frac{x}{e^x}dx+\int_1^2 \frac{x+1}{e^{x-1}}dx+\int_2^3 \frac{x+2}{e^{x-2}}dx+\int_3^4 \frac{x+3}{e^{x-3}}dx+\int_4^5 \frac{x+4}{e^{x-4}}dx$$

$$\int_0^1 xe^{-x}dx=x\left(-e^{-x}\right)-e^{-x}\Big|_0^1$$

$$=\left(-e^0-e^{-1}\right)-\left(0-e^{-0}\right)$$

$$=\frac{-2}{e}+1$$

$$\int_1^2 (x+1)e^{1-x}dx=-(x+1)e^{1-x}-e^{1-x}\Big|_1^2$$

$$=\left(-(3)e^{-1}-e^{-1}\right)-\left(-2e^0-e^0\right)$$

$$=\frac{-3}{e}-\frac{1}{e}+3$$

$$=\frac{-4}{e}+3$$

$$\int_2^3 (x+2)e^{2-x}dx=-(x+2)\left(e^{2-x}\right)-e^{2-x}\Big|_2^3$$

$= -(5)e^{-1} - e^{-1} - \left(-4e^{0} - e^{0}\right)$

$= \frac{-6}{e} + 5$

$\int_{3}^{4}(x+3)e^{3-x}dx = -(x+3)e^{7-x} - e^{7-x}\Big|_{3}^{4}$

$= -7e^{-1} - e^{-1} - \left(-6e^{0} - e^{0}\right)$

$= \frac{-8}{e} + 7$

$\int_{4}^{5}(x+4)e^{4-x}dx = -(x+4)e^{4-x} - \left(e^{4-x}\right)\Big|_{4}^{5}$

$= \left(-9e^{-1} - e^{-1}\right) - \left(-8e^{0} - e^{0}\right)$

$= \frac{-10}{e} + 9$

$\Rightarrow I = \frac{-30}{e} + 25$

$\Rightarrow \alpha = -30$ and $\beta = 25$

$(\alpha + \beta)^2 = 25$