JEE-Main-17-03-2021-Shift-2 (Memory Based)

PHYSICS

Question: If $\vec{E}=\frac{3}{5}\hat{i}+\frac{4}{5}\hat{j},$ then find electric flux through an area of 0.4 m^2 parallel to y-z plane.

Options:

(a) $0.12\frac{Nm^2}{C}$

(b) $0.24\frac{Nm^2}{C}$

(c) $0.36\frac{Nm^2}{C}$

(d) $0.48\frac{Nm^2}{C}$

Answer: (b)

Solution:

$\vec{E}=\frac{3}{5}\hat{i}+\frac{4}{5}\hat{j}$

$\vec{A}=\left(0.4m^2\right)\hat{i}$

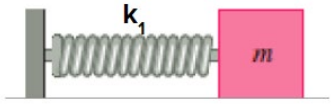
$\phi=\vec{E}\cdot\vec{A}$

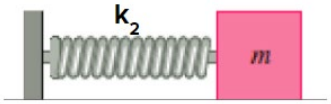
$\phi=\left(\frac{3}{5}\hat{i}+\frac{4}{5}\hat{j}\right)\cdot\left(0.4\hat{i}\right)$

$\phi=\frac{3}{5}\times 0.4\frac{N\,m^2}{C}$

$\phi=0.24\frac{N\,m^2}{C}$

Question: If amplitude of both the SHMs is same then find the ratio of maximum velocities of the two cases.





Options:

(a) $\sqrt{\frac{k_2}{k_1}}$

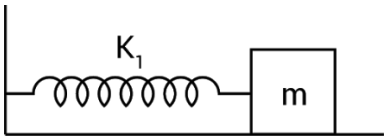
(b) $\sqrt{\frac{k_1}{k_2}}$

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

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

Answer: (b)

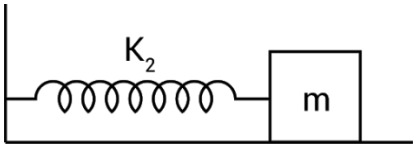
Solution:



$V_{1(\max)} = A\omega_1$

$\omega_1 = \sqrt{\frac{k_1}{m}}$

$V_{1(\max)} = A\sqrt{\frac{k_1}{m}} \quad ...(\mathrm{i})$



$V_{2(\max)} = A\omega_2$

$\omega_2 = \sqrt{\frac{k_2}{m}}$

$V_{2(\max)} = A\sqrt{\frac{F_2}{m}} \quad ...(\mathrm{ii})$

$$\frac{V_{1(\max)}}{V_{2(\max)}} = \frac{A\sqrt{\frac{k_1}{m}}}{A\sqrt{\frac{k_2}{m}}} = \sqrt{\frac{k_1}{k_2}}$$

Question: If the carrier wave is given by $y_c = A_c \sin \omega_c t$ and message signal is $y_s = A_s \sin \omega_s t$, find the bandwidth of the AM wave (in Hz)?

Options:

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

(b) $\frac{2\omega_s}{\pi}$

(c) $\frac{\omega_c - \omega_s}{\pi}$

(d) $\frac{2(\omega_c - \omega_s)}{\pi}$

Answer: (a)

Solution:

Amplitude modulated signal contains frequencies.

$(\omega_c - \omega_s) to (\omega_c + \omega_s)$

Bandwidth = $\omega_c + \omega_s - \omega_c + \omega_s$

Frequency $= \frac{2\omega_s}{2\pi} = \frac{\omega_s}{\pi}$

Question: Particles on a string vibrate with amplitude of 6 cm, speed of wave is 300 m/s and angular frequency of oscillations is 245. Find wave equation of wave is travelling along positive x direction.

Options:

(a) $y = 0.06\sin\left(245t - \frac{49}{60}x\right)$

(b) $y = 0.06\sin\left(245t + \frac{49x}{60}\right)$

(c) $y = 0.06\sin\left(245t - 300x\right)$

(d) $y = 0.06\sin\left(245t + 300x\right)$

Answer: (a)

Solution:

From the question,

$A = 6cm = 0.06m.$

$u = 300\,m/s$

$\omega = 245\,m/s$

$k = \frac{\omega}{v}$

$k = \frac{245}{300}$

$k = \frac{49}{60}$

General equation of wave traveling along +ve x-direction is given by $y = A\sin\left(\omega t - kx\right)$

So, $y = 0.06\sin\left(245t - \frac{49}{60}x\right)$

Question: Light of frequency f_1 and f_2 fall on same metal and the max speed of photo electron is V_1 and V_2 respectively and mass is m. Find relation between V_1 and V_2?

Options:

(a) $V_2^2 - V_1^2 = \frac{h}{2m}\left(f_2 - f_1\right)$

(b) $V_2^2 - V_1^2 = \frac{h}{m}\left(f_2 - f_1\right)$

(c) $V_2^2 - V_1^2 = \frac{2h}{m}\left(f_2 - f_1\right)$

(d) $V_2 - V_1 = \frac{2h}{m}\left(f_2 - f_1\right)$

Answer: (a)

Solution:

$\left(K.E\right)_{\max} = hf - \phi$ [$\phi =$ work function]

$$\frac{1}{2}mv_2^2 = hf_2 - \phi \qquad \ldots(i)$$

$$\frac{1}{2}mv_1^2 = hf_1 - \phi \qquad \ldots(ii)$$

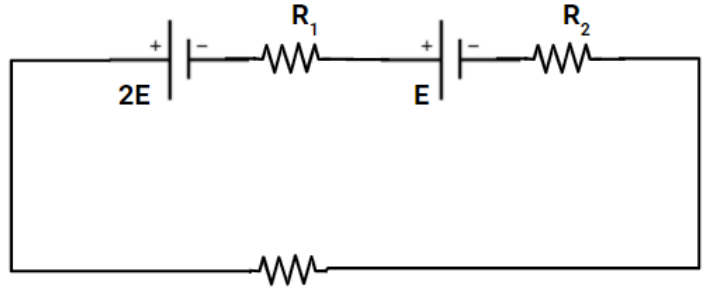
Equation (i)-(ii)s

$$\frac{1}{2}mv_2{}^2 - \frac{1}{2}mv_1{}^2 = \left(hf_2 - \phi\right) - \left(hf_1 - \phi\right)$$

$$\frac{1}{2}m\left(v_2{}^2 - v_1{}^2\right) = hf_2 - hf_1$$

$$v_2{}^2 - v_1{}^2 = \frac{2h}{m}\left[f_2 - f_1\right]$$

Question: Find R such that potential difference across 2ε is zero?



Options:

(a) $\frac{R_1 + R_2}{2}$

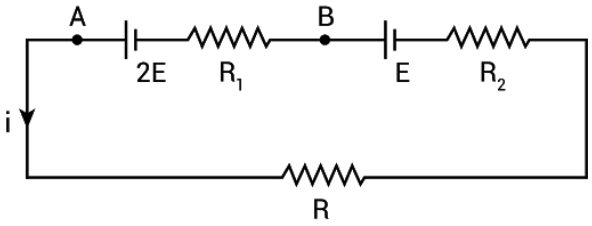
(b) $R_1 - 2R_2$

(c) $\frac{R_1 - R_2}{2}$

(d) $\frac{R_1 - 2R_2}{2}$

Answer: (d)

Solution:



$$i = \frac{V_{eq}}{R_{eq}}$$

$$= \frac{3\varepsilon}{R_1 + R_2 + R}$$

Now, $V_A - 2\varepsilon + iR_1 = V_B$

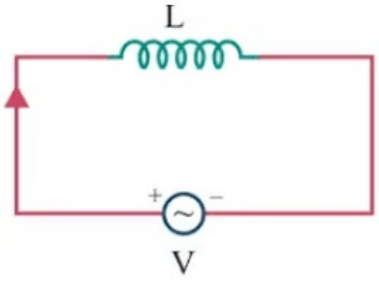
$\Rightarrow V_A - V_B = 2\varepsilon - iR_1$

According to question,

$2\varepsilon - iR_1 = 0$

$$\Rightarrow 2\varepsilon = \frac{3\varepsilon}{R_1 + R_2 + R}.R_1$$
$$\Rightarrow 2R_1 + 2R_2 + 2R = 3R_1$$
$$\Rightarrow R = \frac{R_1 - 2R_2}{2}$$

Question: If ω is doubled in purely inductive circuit. Find the effect on X_L and i?



Options:
(a) No change
(b) Both are doubled
(c) X_L is doubled, current is halved
(d) X_L is halved, current is doubled
Answer: (c)
Solution:
$X_L = \omega L$

As ω is doubled, so X_L will also be doubled.

Now, $i = \frac{V}{X_L} = \frac{V}{\omega L}$

So, if ω is doubled, then i will be halved.

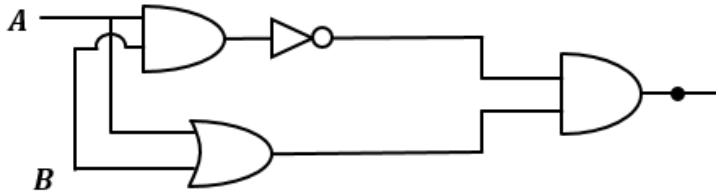
Question: Match the following for AC circuits

Column 1	Column II
1) purely inductive	p) Voltage leads current
2) Purely capacitive	q) current and voltage in phase
3) Purely resistive	r) Current leads voltage
4) Series LCR	s) Current may lead or lag or be in phase of voltage

Answer:
$1 \rightarrow p$
$2 \rightarrow r$
$3 \rightarrow q$
$4 \rightarrow s$
Solution:
In purely inductive circuit current logs voltage by 90 degree. Or voltage leads current by 90 degree.
In purely capacitive circuit current leads voltage by 90 degree.

In purely resistive circuit current and voltage are in phase.
In series LCR circuit current may lead or log or be in phase of voltage depending upon X_L and X_C value.

Question: Identify the equivalent logic gale.



Options:
(a) NOR
(b) NAND
(c) XOR
(d) NOT
Answer: (c)
Solution:

$$\gamma = \overline{(A \cdot B)} \cdot (A + B)$$
$$= (\overline{A} + \overline{B}) \cdot (A + B)$$
$$= A\overline{A} + A\overline{B} + B\overline{A} + B\overline{B}$$
$$= A\overline{B} + \overline{A}B$$
$$= A \oplus B$$

So, the given circuit is XOR Gate.

Question: If the velocity of a particle moving is $V = a + gt + ft^2$ (a, g, f are constants). At t = 0, body is at origin. Find the displacement after t =1 sec.
Options:
(a) $a + g + f$
(b) $g + 2f$
(c) $a + \frac{g}{2} + \frac{f}{3}$
(d) $\frac{a}{2} + \frac{g}{3} + \frac{f}{4}$
Answer: (c)
Solution:
Given that

$$V = a + gt + ft^2$$

So, $\frac{dx}{dt} = a + gt + ft^2$

$$\int_0^x dx = \int_0^1 (a + gt + ft^2)\, dt$$
$$(x - 0) = \left[at + \frac{gt^2}{2} + \frac{ft^3}{3} \right]_0^1$$

$$\boxed{x = a + \frac{g}{2} + \frac{f}{3}}$$

Question: If initial amplitude during a damped oscillation of mass m is 12 cm & after 2 minutes it reduces to 6 cm, then find the damping constant (b).

Options:

(a) $m \ln 2$

(b) $2m \ln 2$

(c) $m^2 \ln 2$

(d) $\frac{1}{m^2} \ln 2$

Answer: (a)

Solution:

$A = A_0 e^{-bt/2m}$

$6 = 12\, e^{-\frac{2b}{2m}}$

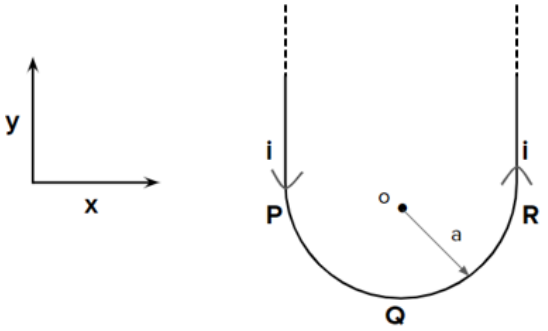
$\frac{1}{2} = e^{-\frac{b}{m}}$

$e^{b/m} = 2$

$\frac{b}{m} = \ln 2$

$\boxed{b = m \ln 2}$

Question: In the fig shown, u-shaped wire, a current i is flowing as shown. Section PQR is a semi circle of radius a. If O is origin then find magnetic field at O.



Options:

(a) $\left(\frac{\mu_0 i}{2\pi a} + \frac{\mu_0 i}{4a}\right)\hat{k}$

(b) $\frac{\mu_0 i}{4a}\hat{k}$

(c) $-\left(\frac{\mu_0 i}{2\pi a} + \frac{\mu_0 i}{4a}\right)\hat{k}$

(d) $-\frac{\mu_0 i}{4a}\hat{k}$

Answer: (a)

Solution:

Magnetic field due to two semi-infinite wire (B_1)

$$\vec{B}_1 = \frac{\mu_0 i}{4\pi a}\hat{k} + \frac{\mu_0 i}{4\pi a}\hat{k}$$

Magnetic field due to semi-circular cell (B_2)

$$\vec{B}_2 = \frac{\mu_0 i}{4a}\hat{k}$$

So, Net magnetic field at O (B_{net})

$$B_{net} = \vec{B}_1 + \vec{B}_2$$

$$= \left(\frac{\mu_0 i}{4\pi a} + \frac{\mu_0 i}{4\pi a} + \frac{\mu_0 i}{4a}\right)\hat{k}$$

$$B_{net} = \left(\frac{\mu_0 i}{2\pi a} + \frac{\mu_0 i}{4a}\right)\hat{k}$$

Question: A sound wave travelling at 300 m/s, having frequency of 245 Hz, has maximum to and fro displacement of 6 cm. Find wavelength

Options:

(a) $\frac{60}{49}m$

(b) $\frac{50}{49}m$

(c) $\frac{79}{50}m$

(d) $\frac{39}{29}m$

Answer: (a)

Solution:

$V_{sound} = 300\,m/s$

$f = 245\,Hz$

$A = 6\,cm$

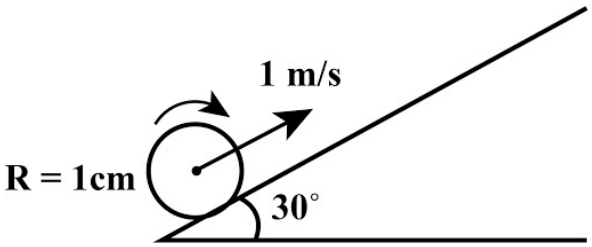
We know

$$V_{sound} = f\lambda \Rightarrow \lambda = \frac{V_{sound}}{f}$$

$$\lambda = \frac{300}{245} = \frac{60}{49}m$$

$$\boxed{\lambda = \frac{60}{49}m}$$

Question: A sphere of radius 1 cm, moving with 1 m/s starts going up the plane performing pure rolling, on an inclined plane of inclination 30º. Find the total time taken by it to go up & come down the plane.



Options:

(a) $\frac{7}{25}\text{sec}$

(b) $\frac{14}{25}\text{sec}$

(c) $\frac{21}{25}\text{sec}$

(d) 1sec

Answer: (b)

Solution:

$$a=\frac{g\sin\theta}{1+\frac{k^2}{R^2}}$$

For solid sphere $mk^2=\frac{2}{5}mR^2$

$$k^2=\frac{2}{5}R^2$$

$$a=\frac{g\sin 30^\circ}{1+\frac{2}{5}}=\frac{5}{7}\times 10\times\frac{1}{2}=\frac{25}{7}ms^{-2}$$

From 1st law of motion

$-1=1-\frac{25}{7}t$ (From energy conservation speed will be same when sphere came down)

$$-2=-\frac{25}{7}t$$

$$t=\frac{14}{25}\text{sec}$$

Question: An object is taken to a depth of 2 km inside an ocean. Percentage change in volume is 1.36%. Find bulk modules of water

Options:

(a) $1.47\times10^9\ N/m^2$

(b) $1.08\times10^9\ N/m^2$

(c) $1.75\times10^9\ N/m^2$

(d) $2.34\times10^9\ N/m^2$

Answer: (a)

Solution:

$$B = -\frac{p}{\Delta v / v}$$

$$B = \frac{1000 \times g \times 2 \times 10^3}{1.36/100}$$

$$B = \frac{2 \times 10^{7+2}}{1.36} = 1.47 \times 10^9 N/m^2$$

Question: Radius of planet is R and time for rotation is 24 hrs. A geostationary satellite is at an altitude of 11R. Find time period of a satellite which is at an altitude of 2R?

Options:

(a) 12 hrs

(b) 8 hrs

(c) 4 hrs

(d) 3 hrs

Answer: (d)

Solution:

We know that $T^2 \propto R^3$

$$T_1^2 \propto (11R + R)^3$$

$$T_2^2 \propto (2R + R)^3$$

$$\Rightarrow \frac{T_2}{T_1} = \left(\frac{3R}{12R}\right)^{3/2}$$

$$\Rightarrow T_2 = \frac{1}{8} \times 24 = 3 \text{ hour}$$

Question: A ball falls from a height of 5 m and each time it rises by $\frac{81}{100}$ of its initial height and so on. (g = 10 m/s^2). Find average speed for a long time?

Options:

(a) $\frac{1000}{19}$

(b) $\frac{905}{361}$

(c) $\frac{1000}{361}$

(d) $\frac{100}{361}$

Answer: (b)

Solution:

Total distance travelled

$$H = 5 + 2 \times \left(5 \times \frac{81}{100} + 5 \times \left(\frac{81}{100}\right)^2 + \ldots\right)$$

$$H = 5 + 2\left(\frac{5\times\frac{81}{100}}{1-\frac{81}{100}}\right)$$

$$H = 5 + 2\times\frac{405}{19} = \frac{810+95}{19} = \frac{905}{19}m$$

$$t = \frac{\sqrt{2gh}}{g} + 2\left[\frac{\sqrt{2gh\times\frac{81}{100}}}{g} + \sqrt{\frac{2gh\times\left(\frac{81}{100}\right)^2}{g}} + \ldots\right]$$

$$t = 1 + 2\left[\sqrt{\frac{81}{100}} + \sqrt{\left(\frac{81}{100}\right)^2} + \ldots\right]$$

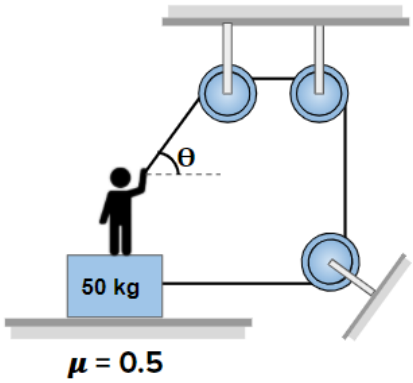
$$t = 1 + 2\left[\frac{9}{10} + \left(\frac{9}{10}\right)^2 + \ldots\right]$$

$$t = \left(1 + \frac{\frac{9}{10}}{1-\frac{9}{10}}\right) = 19\,\text{sec}$$

$$v_{avg} = \frac{H}{t}$$

$$v_{avg} = \frac{905}{19\times19} = \frac{905}{361}m/s$$

Question: Mass of boy is 40 kg and block is 50kg. Assume boy does not slip on block. Find the maximum force that the boy can apply so that block does not slip.



Options:

(a) $f = \frac{900}{2+2\cos\theta+\sin\theta}$

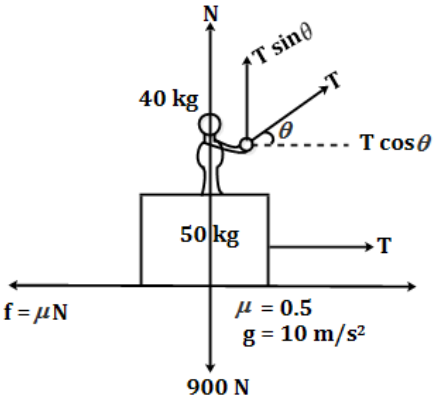
(b) $f = \frac{900}{2+2\cos\theta+2\sin\theta}$

(c) $f = \frac{900}{2+\cos\theta+\sin\theta}$

(d) $f = \dfrac{900}{2+3\cos\theta+\sin\theta}$

Answer: (a)

Solution:



For block to not move

$f \geq T + T\cos\theta$

$\mu N = T + T\cos\theta$ ...(i)

$T\sin\theta + N = 900$ ...(ii)

From (i) and (ii)

$0\cdot5\times\left(900 - T\sin\theta\right) = T\left(1+\cos\theta\right)$

$T = \dfrac{900}{2+2\cos\theta+\sin\theta}$

$F_{max} = T = \dfrac{900}{2+2\cos\theta+\sin\theta}$

JEE-Main-17-03-2021-Shift-2 (Memory Based)

CHEMISTRY

Question: Match the following.

Ores (Column I)	Chemical formula (Column II)
(A) Hematite	**i)** $CuCO_3.Cu(OH)_2$
(B) Magnetite	**ii)** Fe_2O_3
(C) Bauxite	**iii)** Fe_3O_4
(D) Malachite	**iv)** $AlO_x.(OH)_{3-2x}$

Options:

(a) A → (iii); B → (ii); C → (iv); D → (i)

(b) A → (ii); B → (iii); C → (iv); D → (i)

(c) A → (iv); B → (iii); C → (ii); D → (i)

(d) A → (i); B → (iii); C → (ii); D → (iv)

Answer: (b)

Solution: Factual

Question: Which of the following pairs are neutral?
Options:

(a) NO, N_2O
(b) NO_2, N_2O_3
(c) N_2O, N_2O_3
(d) NO, N_2O_3
Answer: (a)

Solution: Nitrous oxide (N_2O) and nitric oxide (NO) are neutral. Dinitrogen trioxide (N_2O_3), nitrogen dioxide (NO_2) are acidic

NO → Neutral

N_2O → Neutral

NO_2 → Acidic

N_2O_3 → Acidic

Question: How many sigma bonds are present in mesityl oxide?

Options:

(a) 5

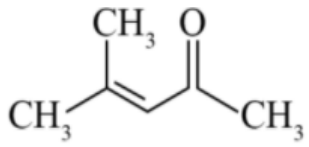
(b) 8

(c) 10

(d) 15

Answer: (d)

Solution:



Question: Which of the following pairs is different from others?

Options:

(a) Li, Mg

(b) Be, Al

(c) B, Si

(d) Li, Na

Answer: (d)

Solution: All other pairs represent elements having diagonal relationship in periodic table.

Question: Fructose is an example of:

Options:

(a) Aldohexose

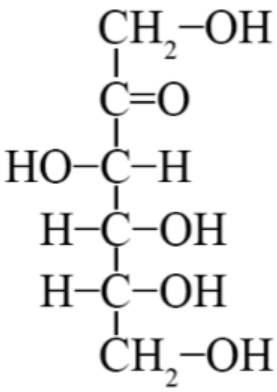
(b) Pyranose

(c) Ketohexose

(d) Ketopentose

Answer: (c)

Solution:



Fructose contain ketone as a main functional and having 6-carbon

So, known as Ketohexose

Question: In 1 g of KBr, 10^{-5} mole percent $SrBr_2$ is doped. Find number of cationic vacancies.

Options:

(a) 10^{15}

(b) 5×10^{15}

(c) 6.023×10^{16}

(d) 5×10^{14}

Answer: (d)

Solution: Moles of KBr = $\frac{1}{119}$

$\frac{1}{119}$ moles of KBr will be doped with $\frac{10^{-5}}{100} \times \frac{1}{119}$ moles of $SrBr_2$

One Sr^{2+} ion will create one cationic vacancy

Thus, total number of cationic vacancies

$\frac{1}{119} \times 10^{-7} \times 6.023 \times 10^{23}$

$= 0.05 \times 10^{16}$

5×10^{14}

Question: In solvay process, during restoration of NH_3, the by-product formed is:

Options:

(a) $Ca(OH)_2$

(b) $CaCl_2$

(c) $NaHCO_3$

(d) NH_4Cl

Answer: (b)

Solution: In solvay process, NH_3 is recovered when the solution containing NH_4Cl is treated with $Ca(OH)_2$. Calcium chloride is obtained as a by-product

$2NH_4Cl + Ca(OH)_2 \rightarrow 2NH_3 + CaCl_2 + H_2O$

Question: If colloid is negatively charged then, the one which coagulates most effectively is:

Options:

(a) Na^+

(b) Ba^{2+}

(c) PO_4^{3-}

(d) SO_4^{2-}

Answer: (b)

Solution: According to Hardy-Schulze rule, greater is the valency of Flocculating ion (having charge opposite to charge on colloid), greater is its coagulation causing power

Question: An aqueous solution of $K_4[Fe(CN)_6]$ ($\alpha = 1$) has molality = 1 molal. If the boiling point of this solution is same as that of aqueous solution of substance A having mass percentage of A = 19.1 %. Find the molar mass of A (in g/mol)

Options:

(a) 47.22

(b) 57.19

(c) 32.15

(d) 236.1

Answer: (a)

Solution: Since boiling point and the solvent is same for both solution

$(\Delta Tb)_1 = (\Delta Tb)_2$

$\Rightarrow i_1.m_1 = i_2.m_2$

$\Rightarrow 5\times1 = \frac{1\times19.1\times1000}{M\times80.9}$

$\Rightarrow M = \frac{19.1\times1000}{5\times80.9} = 47.22\,g/mol$

Question: Fe is in its ground state. Find its spin magnetic moment.

Options:

(a) 1.9 B.M

(b) 2.5 B.M

(c) 3.1 B.M

(d) 4.9 B.M

Answer: (d)

Solution:

Fe = [Ar] $4s^2$ $3d^6$

n = 4

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

$= \sqrt{24}$ B.M

$= 4.9$ B.M

Question: Which of the following is linear molecule?

Options:

(a) N_2O

(b) ClO^-

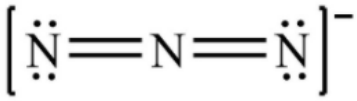
(c) N_3^-

(d) All of these

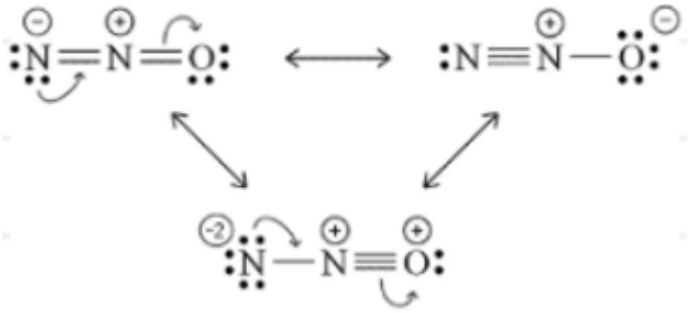
Answer: (d)

Solution:

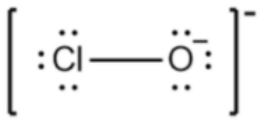
N_3^-



N_2O



ClO^-



Question:

$$\text{Sucrose} \xrightarrow{\text{Enzyme1}} \text{Fructose} + \text{Glucose}$$

$$\text{Glucose} \xrightarrow{\text{Enzyme 2}} \text{Ethyl alcohol}$$

Identify enzyme 1 and enzyme 2

Options:

(a) Invertase, Maltase

(b) Maltase, Zymase

(c) Invertase. Zymase

(d) Zymase, Invertase

Answer: (c)

Solution:

$$\text{Sucrose} \xrightarrow{\text{Invertase}} \text{Fructose} + \text{Glucose}$$

$$\text{Glucose} \xrightarrow{\text{Zymase}} \text{Ethyl alcohol}$$

Question: What are the common oxidation states of Chromium?

Options:

(a) +1 to +6

(b) +2 to +6

(c) +3 to +6

(d) +1 and +3

Answer: (b)

Solution: Chromium shows oxidation number +2 to +6, out of which +3 and +6 are most common

Question: Which series in hydrogen line spectrum falls under visible region?
Options:

(a) Lyman

(b) Balmer

(c) Paschen

(d) Pfund

Answer: (b)

Solution: Factual

Question: Primary, secondary and tertiary amines can be distinguished by which test?

Options:

(a) KOH, $CHCl_3$

(b) Para toluene sulfonyl chloride

(c) Benzene sulfonic acid

(d) Hofmann mustard oil reaction

Answer: (b)

Solution: Hinsberg reagent

$$C_6H_5SO_2Cl + CH_3-CH_2-NH_2 \xrightarrow{-HCl} C_6H_5SO_2\underset{\underset{H}{|}}{N}-CH_3$$

(Base soluble compound)

$$C_6H_5SO_2Cl + (CH_3-CH_2)_2-NH \xrightarrow{-HCl} C_6H_5SO_2\underset{\underset{CH_2-CH_3}{|}}{N}-CH_2-CH_3$$

(Base insoluble)

$C_6H_5SO_2Cl + (CH_3–CH_2)_3–N \rightarrow$ No reaction

Question: Match the following:

Column I	Column II
(A) $[Co(NH_3)_6]$ $[Cr(CN)_6]$	**i)** Linkage
(B) $[Co(NH_3)_5(NO_2)]Cl_2$	**ii)** Coordination
(C) $[Cr(H_2O)_6]Cl_3$	**iii)** Optical
(D) Cis-$[CrCl_2en_2]^{3-}$	**iv)** Solvate

Options:

(a) A → (i); B → (ii); C → (iv); D → (iii)

(b) A → (ii); B → (i); C → (iv); D → (iii)

(c) A → (iii); B → (i); C → (iv); D → (ii)

(d) A → (iv); B → (ii); C → (iii); D → (i)

Answer: (b)

Solution:

A) $[Co(NH_3)_6]$ $[Cr(CN)_6]$

Interchange of ligands is possible between coordinate entities. Thus, coordination isomerism

B) $[Co(NH_3)_5(NO_2)]Cl_2$

NO_2 is ambidentate and can be bind as –ONO.

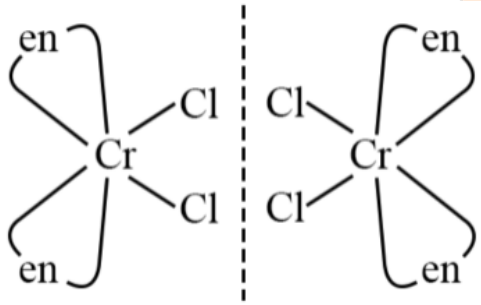
Thus, linkage isomerism

C) $[Cr(H_2O)_6]Cl_3$

Water can also be present as free solvent molecule i.e.,

$[Cr(H_2O)_5]Cl_2.H_2O$. Thus solvate isomerism

D) Cis-$[CrCl_2en_2]^{3-}$



Since, non-superimposable mirror images are possible compound shows optical isomerism

Question: Which of the following is ambident nucleophile?

Options:

(a) KCN / AgCN

(b) KNO_2 / $AgNO_2$

(c) KI / AgI

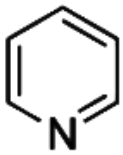
(d) Both (a) and (b)

Answer: (d)

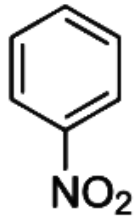
Solution: The nucleophiles that can attack through two different sites are known as ambident nucleophiles. Ambident nucleophile are having 2 donor sites.

Question: Which of the following can be estimated by Kjeldahl's method?
Options:

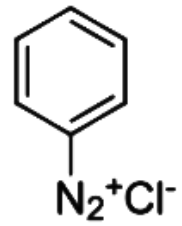
(a)



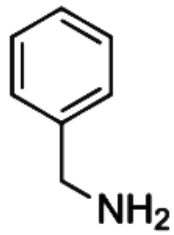
(b)



(c)



(d)



Answer: (d)

Solution: The Kjeldahl's method is not applicable to nitro, diazogroups and compound in which nitrogen atom present in the ring

Because in the above three case nitrogen atom can’t be converted to ammonium sulphate under the reaction conditions

Question: Which of the following is wrong for eutrophication?

Options:

(a) Detergents increase it

(b) Fertilizer increase it

(c) Plant growth increase

(d) Not enough nutrients for plants to grow

Answer: (c)

Solution: eutrophication decreases dissolved oxygen of water

Question: S1: 2-methyl butane is oxidized by $KMnO_4$ to 2-methyl-2-butanol.

S2: n-alkane is easily oxidized to alcohol by $KMnO_4$

Options:

(a) Both S1 and S2 are correct

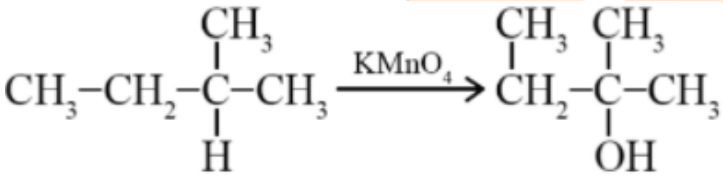
(b) S1 is correct, S2 is wrong

(c) S2 is correct, S1 is wrong

(d) Both S1 and S2 are wrong

Answer: (b)

Solution: $KMnO_4$ oxidises alkanes containing tertiary hydrogen to corresponding alcohols



So, S1 is correct while S2 is wrong

Question: In the reaction of aniline with HNO_3, meta product is formed as 47% because

Options:

(a) Anilinium ion is formed

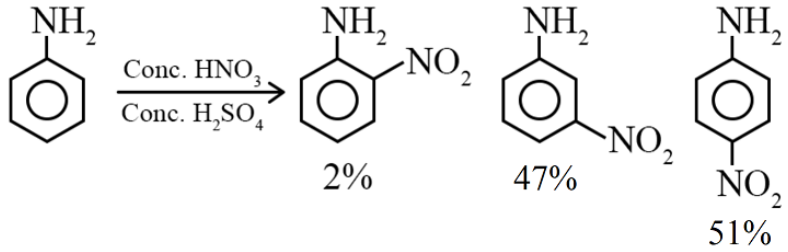
(b) NH_2 is meta directing

(c) Of low temperature

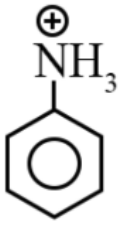
(d) NO_2 is meta directing

Answer: (a)

Solution:



In acidic medium Anilinium ion is formed which is meta directing in nature



Question: Find the compound in which hydrolysis does not take place

Options:

(a) SF_6

(b) BF_3

(c) XeF_4

(d) XeF_6

Answer: (a)

Solution: In SF_6 the fluorine atoms attached to the sulphur act as shield, and that's why SF_6 is chemically inert towards hydrolysis

Question: $[Fe(CN)_6]^{3-}$ and $[Cr(CN)_6]^{3-}$. Find the hybridisation and magnetic character

Options:

(a) d^2sp^3, paramagnetic

(b) d^2sp^3, diamagnetic

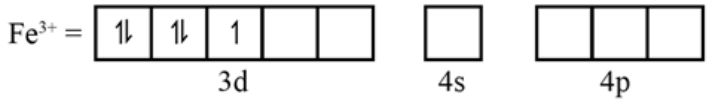
(c) sp^3d^2, paramagnetic

(d) sp^3d^2, diamagnetic

Answer: (a)

Solution: $Fe^{3+} \Rightarrow [Ar]\ 3d^5$

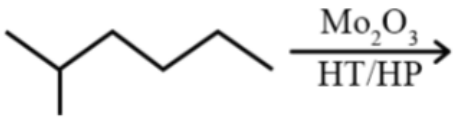
Since, CN^- is a strong field ligand



Thus, hybridization $\Rightarrow d^2sp^3$

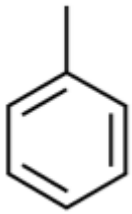
Magnetic character $\Rightarrow$ paramagnetic

Question:



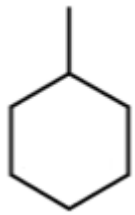
Options:

(a)



(b)

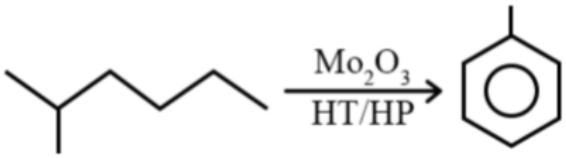
(c)



(d)

Answer: (a)

Solution:



Alkanes having six to 10 carbon atoms are converted into benzene and its homologues at high pressure and temperature in presence of catalyst.

JEE-Main-17-03-2021-Shift-2 (Memory Based)

MATHEMATICS

Question: $16(p \wedge q) \oplus (p \otimes q)$ is tautology, $\oplus, \otimes =$

Options:

(a) $\rightarrow \rightarrow$

(b) $\wedge \rightarrow$

(c) $\vee \rightarrow$

(d) $\wedge \vee$

Answer: (a)

Solution:

$(p \wedge q) \rightarrow (p \rightarrow q)$

$(p \wedge q) \rightarrow (\sim p \vee q)$

$(\sim p \vee \sim q) \vee (\sim p \vee q)$

$\sim p \vee (\sim q \vee q) \Rightarrow$ Tautology

$\Rightarrow \oplus \Rightarrow \rightarrow$

$\otimes \Rightarrow \rightarrow$

Question: $S_1 = \{|z-1| < \sqrt{2}\}$, $S_2 = \{\text{Re}(z(1-i))\} \geq 1$, $S_3 = \{\text{Im}\, z < 1\}$. Then $S_1 \cap S_2 \cap S_3$

Options:

(a) is singletonset

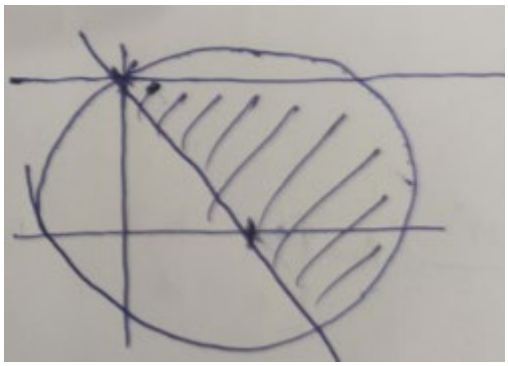
(b) Has so many elements

(c) Has exactly 2 elements

(d) Is null set

Answer: (b)

Solution:



$S_1 = |z-1| < \sqrt{2} \Rightarrow (x-1)^2 + y^2 < 2$

$S_2 = \text{Re}\left(z\left(1-i\right)\right) \geq 1 \Rightarrow x+y \geq 1$

$S_3 = \text{Im}\left(z\right) < 1 \Rightarrow y < -1$

$\Rightarrow S_1 \cap S_2 \cap S_3$ has so many elements

Question: $\sin^{-1}\left[x^2+\frac{1}{3}\right]+\cos^{-1}\left[x^2-\frac{2}{3}\right]=x^2,$ number of solutions in $x \in (1,1)$

Options:

(a) 0

(b) 2

(c) 3

(d) 4

Answer: (a)

Solution:

$\sin^{-1}\left[x^2+\frac{1}{3}\right]+\cos^{-1}\left(\left[x^2+\frac{1}{3}\right]-1\right)=x^2 \;;\; x \in (-1,1)$

$\Rightarrow \sin^{-1}\left(t\right)+\cos^{-1}\left(t-1\right)=x^2$, where $t=\left[x^2+\frac{1}{3}\right]$ = Integer

$\therefore t = 0,1$

(a) when $t=0 \Rightarrow x^2=\pi$ and $x^2 < \frac{2}{3}$

(b) when $t=1 \Rightarrow x^2=\pi$ and $\frac{2}{3} < x^2 < \frac{5}{3}$

No solution

Question: Variance of 3n observations is 4 mean of first 2n observations is 6 and mean of next n observations is 3. If 1 is added in first 2n observation and 1 is subtracted from last n observations than find new variance.

Options:

(a)

(b)

(c)

(d)

Answer: ()

Solution:

Given observation be

$x_1, x_2, x_3, x_4 .... x_{2n}, x_{2n+1} .... x_{3n}$

$\therefore \dfrac{x_1 + x_2 + ... + x_{2n}}{2n} = 6$

And $\dfrac{x_{2n+1} + x_{2n+2} + ... + x_{3n}}{n} = 3$

$\therefore x_1 + x_2 + ... + x_{3n} = 15n$

Thus mean of 3n observation = $\dfrac{15n}{3n} = 5$

Now, given variance is 4

$\therefore \dfrac{\sum_{i=1}^{3n} x_i^2}{3n} - \left(\bar{X}\right)^2 = 4$

$\therefore \dfrac{\sum_{i=1}^{3n} x_i^2}{3n} = 4 + 25$

$\sum_{i=1}^{3n} x_i^2 = 87n$

Now new mean will be $\bar{X}'$

$= \dfrac{x_1 + x_2 + ... + x_{3n} + 2n(1) - (1 \times n)}{3n}$

$= \dfrac{x_1 + x_2 + ... + x_{3n}}{3n} + \dfrac{n}{3n}$

$\bar{X}' = \dfrac{16}{3}$

Now, new variance

$= \dfrac{\left(\sum_{i=1}^{2n} (x_i + 1)^2 + \sum_{i=2n+1}^{2n} (x_i - 1)^2\right)}{3n} - \left(\bar{X}'\right)^2$

$= \dfrac{\left(\sum_{i=1}^{3n} (x_i)^2 + 2n(1) + n(1) + 2\sum_{i=1}^{2n} x_i - 2\sum_{i=2n+1}^{3n} x_i\right)}{3n} - \left(\bar{X}'\right)^2$

$= \dfrac{87n + 3n + 2(12n) - 2(3n)}{3n} - \left(\dfrac{16}{3}\right)^2$

$$= \frac{108}{3} - \frac{256}{3} = \frac{68}{9}$$

Question: $\sum_{r=0}^{6} {}^{n}C_{r} \times {}^{n}C_{6-r} = ?$

Options:

(a)

(b)

(c)

(d)

Answer: ()

Solution:

$$\sum_{r=0}^{6} {}^{6}C_{r} \times {}^{6}C_{6-r} = {}^{12}C_{6}$$

Question: Probability of '0' at odd position is $\frac{1}{3}$ and probability of '0' at even position is $\frac{1}{2}$.

Find the probability that 10 is immediately followed by 01.

Options:

(a)

(b)

(c)

(d)

Answer: ()

Solution:

For 0110 $\Rightarrow$ Probability = $\frac{1}{3} \times \frac{1}{2} \times \frac{2}{3} \times \frac{1}{2} = \frac{1}{18}$

Question: Find $\lim_{\theta \to \infty} \frac{\tan\left(\pi \cos^2 \theta\right)}{\sin\left(2\pi \sin^2 \theta\right)}$

Options:

(a) $-\frac{1}{4}$

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

(c) $\frac{-1}{2}$

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

Answer: (c)

Solution:

$$\lim_{\theta\to 0}\frac{\tan\left(\pi\cos^2\theta\right)}{\sin\left(2\pi\sin^2\theta\right)}$$

$$=\lim_{\theta\to 0}\frac{\tan\left(\pi\cos^2\theta\right)}{\sin\left(2\pi\cos^2\theta\right)}=-\lim_{\theta\to 0}\frac{1}{2}\sec^2\left(\pi\cos^2\theta\right)=\frac{-1}{2}$$

Question: $f(x)=\begin{cases}\left(2-\sin\frac{1}{2}\right); & x\neq 0\\ 0; & x=0\end{cases}$

Options:

(a) Monotonic in $(-\infty,0)\cup(0,\infty)$

(b) non Monotonic in $(-\infty,0)\cup(0,\infty)$

(c)

(d)

Answer: (b)

Solution:

$$f(x)=\begin{cases}2x-x\sin\frac{1}{x} & ;\quad x>0\\ -2x+x\sin\frac{1}{x} & ;\quad x<0\end{cases}$$

$$f'(x)=\begin{cases}2-\frac{d}{dx}\left[x\sin\frac{1}{x}\right] & ;\quad x>0\Rightarrow f'(x)>0\\ -2+\frac{d}{dx}\left[x\sin\frac{1}{x}\right] & ;\quad x<0\Rightarrow f'(x)<0\end{cases}$$

$\Rightarrow f(x)$ is non-monotonic in $(-\infty,0)\cup(0,\infty)$

Question: $f(x)=e^{-x}\sin x,\ F(x)=\int_0^x f(t)\,dt.$ Find $\int_0^1 e^x\left(F'(x)+f(x)\right)dx$ lie in

Options:

(a) $\left(\frac{330}{360}, \frac{331}{360}\right)$

(b) $\left(\frac{327}{360}, \frac{329}{360}\right)$

(c) $\left(\frac{335}{360}, \frac{336}{360}\right)$

(d)

Answer: (a)

Solution:

$f(x) = e^{-x} \sin x \; ; \; f'(x) = f(x)$

$\therefore I = \int_0^1 e^x . \, 2f(x)\,dx = 2\int_0^1 \sin x \, dx = -2\left(\cos x\right)_0^1$

$= -2\left[\cos 1 - 1\right] = 2 - 2\cos 1 = 0.9194 \in \left(\frac{330}{360}, \frac{331}{360}\right)$

Question: $\lim_{n\to\infty} \frac{[r] + [2r] + \ldots + [nr]}{n^2}$

Options:

(a)

(b)

(c)

(d)

Answer: ()

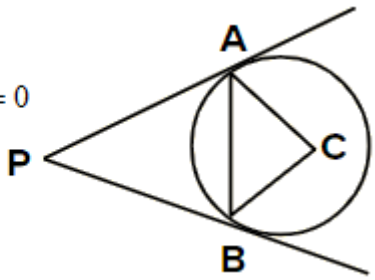
Solution:

$\lim_{n\to\infty} \frac{\left(r + 2r + \ldots . nr\right)}{n^2} - \left[\frac{\{r\} + \{2r\} + \{3r\} + \ldots \{nr\}}{n^2}\right]$

$= \lim_{n\to\infty} \frac{r \cdot n\left(n+1\right)}{2n^2} = \frac{r}{2}$

Question: If angle between tangents is $\tan^{-1}\left(\frac{12}{5}\right)$, ratio of $ar\ \Delta PAB$ and $ar\ \Delta CAB =$

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



Options:

(a)

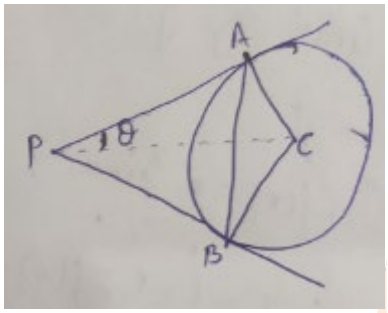
(b)

(c)

(d)

Answer: ()

Solution:



Angle between tangents $= 2\theta = \tan^{-1}\left(\frac{12}{5}\right)$

$$\frac{2\tan\theta}{1-\tan^2\theta} = \frac{17}{5} : r = 1$$

$$6\tan^2\theta + 5\tan\theta - 6 = 0$$

$$6\tan^2\theta + 9\tan\theta - 4\tan\theta - 6 = 0$$

$$3\tan\theta(2\tan\theta + 3) - 2(\tan\theta + 3) = 0$$

$$\Rightarrow \tan\theta = \frac{2}{3} = \frac{AC}{AP}$$

$$AP = \frac{3r}{2} = \frac{3}{2} = BP$$

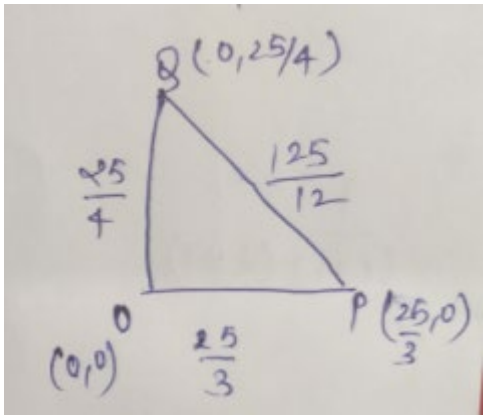
$$\therefore \frac{Ar\ \Delta PAB}{Ar\ \Delta CAB} = \frac{PA.PB.\sin P}{AC.BC.\sin C} = \frac{\frac{9}{4}\left(\frac{12}{13}\right)}{1\left(\frac{12}{13}\right)} = \frac{9}{4}$$

Question: $x^2 + y^2 = 25$, tangent to it at (3, 4) meet axes at P and Q. A circle is drawn passing through origin with its center at incenter of Δ OPQ. Find radius of that circle

Options:

(a)

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



Equation of tangent $\Rightarrow 3x+4y=25$; $P\left(\frac{25}{3},0\right)$; $Q\left(0,\frac{25}{4}\right)$

Centre of circle = $\left(\frac{\frac{625}{12}}{\frac{300}{12}},\frac{\frac{625}{12}}{\frac{300}{12}}\right)$

Centre = $\left(\frac{25}{12},\frac{25}{12}\right)$

$\therefore$ Radius = $\frac{25\sqrt{2}}{12}$

Question: $\cos x\left(3\sin x+\cos x+3\right)dx=dx\left(1+y\sin x\left(3\sin x+\cos x+3\right)\right)y\left(0\right)=0$. Find $y\left(\frac{\pi}{3}\right)$.

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

$$\cos x\left(3\sin x+\cos x+3\right)\frac{dy}{dx}-y\sin x\left(3\sin x+\cos x+3\right)=1$$

$$\Rightarrow \frac{dy}{dx} - \tan xy = \frac{1}{\cos x\left(3\sin x + \cos x + 3\right)}$$

$$IF = e^{\int -\tan x\,dx} = \cos x$$

$$\therefore\ y\cos x = \int \frac{dx}{3\sin x + \cos x + 3} = \int \frac{\sec^2 \frac{x}{2}dx}{6\tan\frac{x}{2} + 1 - \tan^2\frac{x}{2} + 3 + 3\tan^2\frac{x}{2}}$$

$$y\cos x = \int \frac{\sec^2 \frac{x}{2}dx}{2\tan^2\frac{x}{2} + 6\tan\frac{x}{2} + 4}$$

Let $\tan\frac{x}{2} = t \Rightarrow \frac{1}{2}\sec^2\frac{x}{2}dx = dt$

$$y\cos x = \int \frac{dt}{t^2 + 3t + 2} = \int \frac{-1}{(t+2)} + \frac{1}{(t+1)}dt$$

$$y\cos x = \ln\left(\frac{t+1}{t+2}\right) + c$$

$$y\cos x = \ln\left[\frac{1+\tan\frac{x}{2}}{2+\tan\frac{x}{2}}\right] + c \Rightarrow c = \ln 2$$

$$y\cos x = \ln 2\left[\frac{1+\tan\frac{x}{2}}{2+\tan\frac{x}{2}}\right]$$

$$\text{At } x = \frac{\pi}{3} \Rightarrow y = 2\ln 2\left[\frac{1+\frac{1}{\sqrt{3}}}{2+\frac{1}{\sqrt{3}}}\right] = 2\ln 2\left(\frac{\sqrt{3}+1}{2\sqrt{3}+1}\right)$$

Question: $A = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$, $B = \begin{bmatrix} \alpha \\ \beta \end{bmatrix} B$ is non-zero matrix, $AB = B$, $a + d = 2021$ find $ad - bc$

Answer: 2020.00

Solution:

$$AB = B \Rightarrow \begin{bmatrix} a & b \\ c & d \end{bmatrix}\begin{bmatrix} \alpha \\ \beta \end{bmatrix} = \begin{bmatrix} \alpha \\ \beta \end{bmatrix}$$

$a\alpha + b\beta = \alpha \Rightarrow (a-1)\alpha + b\beta = 0$

$c\alpha + d\beta = \beta \Rightarrow c\alpha + (d-1)\beta = 0$

$$\Rightarrow \begin{vmatrix} a-1 & b \\ c & d-1 \end{vmatrix} = 0$$

$\Rightarrow (a-1)(d-1) - bc = 0$

$\Rightarrow ad - (a+d) + 1 - bc = 0$

$ad - bc = (a+d) - 1 = 2020$

Question: $y^2 = 4x - 20,$ tangent to this parabola at $(6, 2)$ is also tangent to $\frac{x^2}{2} + \frac{y^2}{b} = 1,$ find b^2.

Answer: 196.00

Solution:

Equation of tangent to $y^2 = 4x - 20$ at (6, 2) is

$2y = 2(x+6) - 20 \Rightarrow y = x - 4$

$\because$ It is tangent to $\frac{x^2}{2} + \frac{y^2}{b} = 1$

$\Rightarrow 16 = 2 \times 1 + b$

$\Rightarrow b = 14$

$\Rightarrow b^2 = 196$

Question: $\int_0^{10} \frac{\sin[2\pi x]}{e^{e-[x]}} dx = \alpha e^{-1} + \beta e^{\frac{-1}{2}} + \gamma.$ Find $\alpha + \beta + \gamma = ?$

Answer: 0.00

Solution:

$$I = \int_0^{10} \frac{\sin(2\pi x)}{e^{\{x\}}} dx = 10\int_0^1 e^{-x}.\sin(2\pi x)\,dx$$

$$= 10\left[\frac{e^{-x}}{1+4\pi^2}\{-\sin(2\pi x) - 2\pi\cos(2\pi x)\}\right]_0^1$$

$$= \frac{10}{1+4\pi^2}\left[e^{-1}\{-2\pi\} - \{-2\pi\}\right] = \frac{20\pi}{1+4\pi^2}\left[1-\frac{1}{e}\right]$$

$$\Rightarrow \alpha = \frac{-20\pi}{1+4\pi^2},\ \beta = 0,\ \gamma = \frac{20\pi}{1+4\pi^2}$$

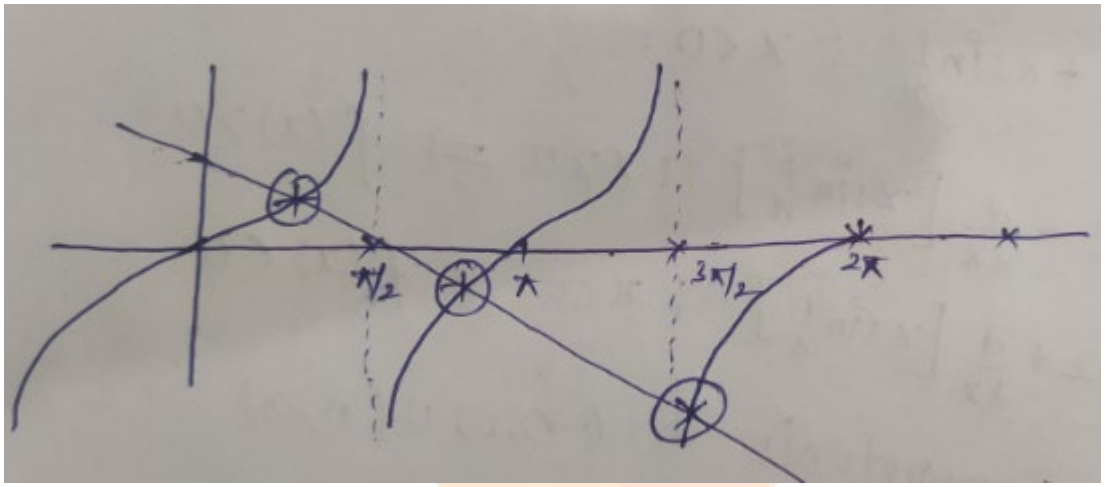
$$\Rightarrow \alpha + \beta + \gamma = 0$$

Question: $x + 2\tan x = \frac{\pi}{2}$ find values of x is $x \in [0,\ 2\pi]$

Answer: 3.00

Solution:

$$x + 2\tan x = \frac{\pi}{2} \Rightarrow \tan x = \frac{\pi}{4} - \frac{x}{2};\ x \in [0, 2\pi]$$



Graph of $y = \tan x$ and $y = \frac{\pi}{4} - \frac{x}{2}$ intersects at 3 points