JEE-Main-18-03-2021-Shift-2 (Memory Based)

PHYSICS

Question: A proton cannot split into a neutron:-

Options:

(a) Because a proton is heavier than neutron

(b) A proton can convert into the neutron inside the nucleus.

(c) It is not possible to convert proton to neutron in any condition

(d) None of these

Answer: (b)

Solution:

The transformation of a free proton to a neutron is energetically impossible, since a free neutron has greater mass than a free proton. But a high-energy collision of a proton and electron or neutrino can result in a neutron.

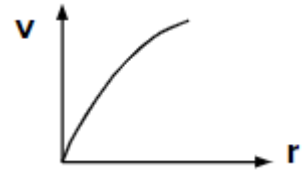
So, a proton can convert into the neutron inside the nucleus.

Question: Force acting on a particle moving in a circle is given $F = \frac{-U}{r}$ where U is the potential energy and r is the radius. The correct graph between speed and radius of particles will be

Options:

(a)

(b)



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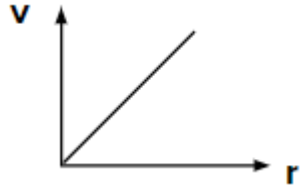

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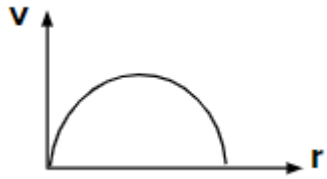


Answer: (b)

Solution:

$$F = -\frac{U}{r}$$

$$m\frac{dv}{dt} = -\frac{U}{r}$$

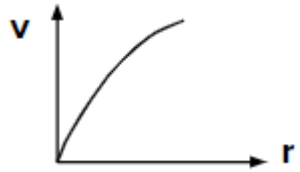
$$m.\frac{dv}{dr}.\frac{dr}{dt} = -\frac{U}{r}$$

$$m\int v\,dv = -\int \frac{U dr}{r}$$

$$m\frac{v^2}{2} = -U\ln r + C$$

$$v^2 = -\frac{2U}{m}\ln r + \frac{2C}{m}$$

$$v = \sqrt{\frac{2C}{m} - \frac{2U}{m}\ln r}$$

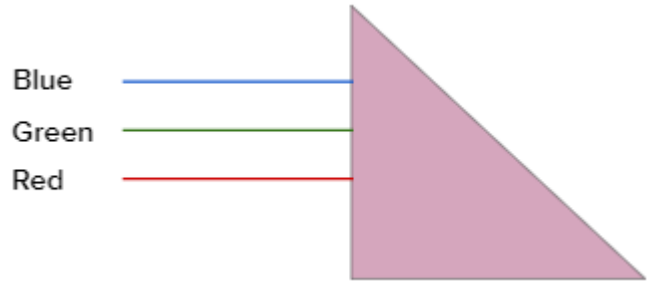


Question: Which of the following colors pass through the prism?

$\mu_B = 1.49$

$\mu_G = 1.41$

$\mu_R = 1.27$

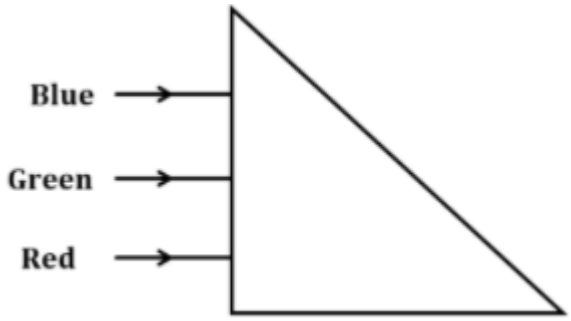


Options:

(a) All three

(b) Blue

(c) Red
(d) None
Answer: (c)
Solution:



$\mu_B = 1.49, \mu_G = 1.41, \mu_R = 1.27$

Incident angle $= i$, Critical angle $= i_c$

$i > i_c$ (Total internal reflection will take place)

$$\theta_C = \sin^{-1}\left(\frac{1}{\mu}\right)$$

$$\theta_{BC} = \sin^{-1}\left(\frac{1}{1.49}\right) = 42.15°$$

$$\theta_{GC} = \sin^{-1}\left(\frac{1}{1.41}\right) = 45.17°$$

$$\theta_{RC} = \sin^{-1}\left(\frac{1}{1.27}\right) = 51.94°$$

Red ray have larger angle, so it will pass the prism.

Question: In a nuclear decay process if $\frac{n}{p}$ ratio increases then which decay process may have occurred:-

Options:

(a) β^- decay

(b) γ decay

(c) β^+ decay

(d) None of these

Answer: (c)

Solution:

Assume ratio active nuclei ${}^{A}_{Z}X$

${}^{A}_{Z}X \rightarrow {}^{A}_{Z+1}Y + \beta^- + \bar{\nu} \Rightarrow \frac{n}{P}$ ratio decreases.

${}^{mA}_{Z}X \rightarrow {}^{A}_{Z}X + \gamma \Rightarrow \frac{n}{P}$ ratio remains constant.

$^{A}_{Z}X \rightarrow ^{A}_{Z-1}Y + \beta^{+} + \bar{\nu} \Rightarrow \frac{n}{P}$ ratio increases.

Question: The areal velocity of a planet of mass m moving in elliptical orbit around the sun, with an angular momentum of L units, is equal to:

Options:

(a) $\frac{dA}{dt} = \frac{L}{m}$

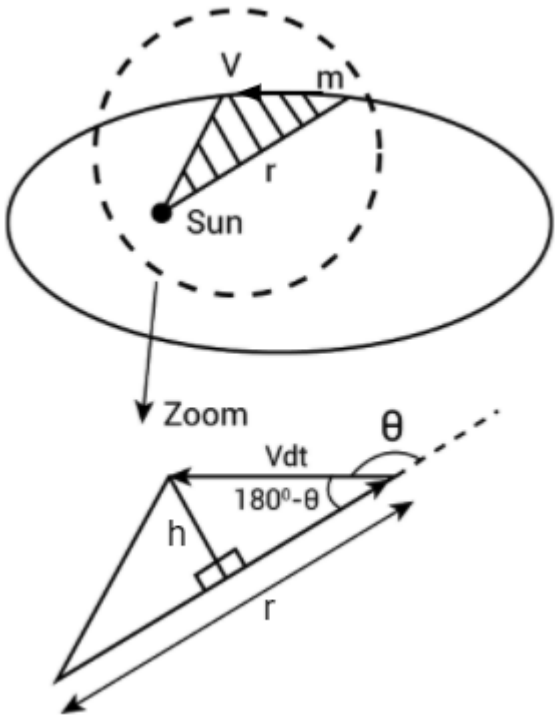
(b) $\frac{dA}{dt} = \frac{2m}{L}$

(c) $\frac{dA}{dt} = \frac{L}{2m}$

(d) $\frac{dA}{dt} = \frac{m}{L}$

Answer: (c)

Solution:



So $\left|\vec{L}\right| = mrv\sin\theta$

Form geometrical diagram

$\sin(180° - \theta) = \frac{h}{vdt}$

$h = vdt\sin\theta \quad ....(1)$

Again

$$dA = \frac{1}{2} \times r \times h$$

$$dA = \frac{1}{2} rvdt \sin\theta$$

$$\frac{dA}{dt} = \frac{1}{2} rv \sin\theta \left(\frac{m}{m}\right)$$

$$\frac{dA}{dt} = \frac{1}{2} \frac{mvr \sin\theta}{m} \Rightarrow \boxed{\frac{dA}{dt} = \frac{L}{2m}}$$

Question: What is the ratio of RMS and average speed of oxygen molecules?
Options:

(a) $\sqrt{\frac{3\pi}{8}}$

(b) $\sqrt{\frac{3}{2}}$

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

(d) $\sqrt{\frac{8}{3\pi}}$

Answer: (a)
Solution:
We know,

$$V_{rms} = \sqrt{\frac{3RT}{M}}$$

$$V_{avg} = \sqrt{\frac{8}{\pi}\frac{RT}{M}}$$

$$\frac{V_{rms}}{V_{avg}} = \frac{\sqrt{\frac{3RT}{M}}}{\sqrt{\frac{8}{\pi}\frac{RT}{M}}}$$

$$\boxed{\frac{V_{rms}}{V_{avg}} = \sqrt{\frac{3\pi}{8}}}$$

Question: A sphere of radius 7.5 ± 0.85 cm is given find the percentage error in the volume?
Options:

(a) 37.9 %

(b) 34 %

(c) 30 %

(d) 40 %

Answer: (b)

Solution:

Volume of sphere $(V) = \frac{4}{3}\pi r^3$

Taking log both the sides and differentiating partially

$$\frac{dV}{V} = \frac{3dr}{r}$$

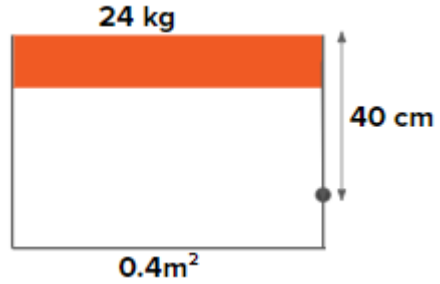
For percentage error

$$\frac{dV}{V} \times 100 = 3\left(\frac{dr}{r}\right) \times 100$$

$$= 3 \times \frac{0.85}{7.5} \times 100$$

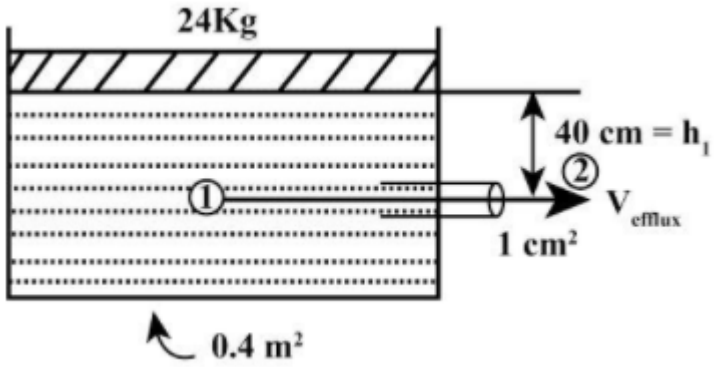
$$\left(\frac{dV}{V} \times 100\right) = 34\%$$

Question: A piston (smooth and free) is placed on free surface of fluid (water) as shown. Find speed of efflux?



Answer: 3 m/s

Solution:



Applying Bernoulli's equation at (1) and (2)

$$P_0 + P_{\text{piston}} + \rho g h_1 + \frac{1}{2}\rho V^2 = P_0 + \frac{1}{2}\rho V_{\text{efflux}}^2 + \rho g h_2$$

From diagram

$$P_{\text{piston}} + \rho g h_1 = \frac{1}{2}\rho V_{\text{efflux}}^2$$

$$\left(\frac{240}{0.4}\right)+1000\times10\times\left(40\times10^{-2}\right)=\frac{1}{2}\times1000\times\left(V_{efflux}\right)^2$$

$$600+4000=\frac{1}{2}\times1000\times\left(V_{efflux}\right)^2$$

$$V_{efflux}=\sqrt{\frac{4600\times2}{1000}}$$

$$V_{efflux}=3.03=3\,m/s \text{ (Approx.)}$$

Question: A proton and alpha particle with kinetic energies K_p and K_α respectively enters a region of uniform magnetic field perpendicularly. The ratio of radii $R_P:R_\alpha=2:1$. Then find $K_P:K_\alpha$?

Options:

(a) 4: 1

(b) 1: 4

(c) 8: 1

(d) 1: 8

Answer: (a)

Solution:

$$\frac{K_P}{K_\alpha}=\frac{\frac{1}{2}m_P\left(\frac{q_PBR_P}{m_P}\right)^2}{\frac{1}{2}m_\alpha\left(\frac{q_\alpha BR_\alpha}{m_\alpha}\right)^2}$$

$$\frac{K_P}{K_\alpha}=\left(\frac{M_p}{M_\alpha}\right)\left(\frac{q_PR_P}{q_\alpha R_\alpha}\right)^2\left(\frac{M_\alpha}{M_P}\right)^2$$

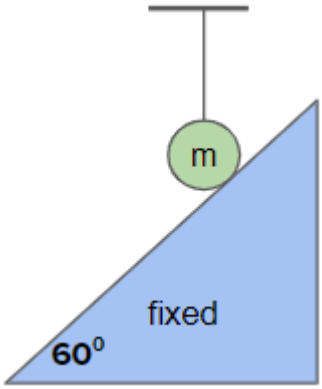
$$\frac{K_P}{K_\alpha}=\left(\frac{M_\alpha}{M_P}\right)\left(\frac{q_P}{q_\alpha}\right)^2\left(\frac{R_P}{R_\alpha}\right)^2$$

$$\frac{K_P}{K_\alpha}=\left(\frac{4M_P}{M_P}\right)\left(\frac{e}{2e}\right)^2\times\left(\frac{2}{1}\right)^2$$

$$\frac{K_P}{K_\alpha}=4\times\frac{1}{4}\times4$$

$$\boxed{\frac{K_P}{K_\alpha}=\frac{4}{1}}$$

Question: A sphere of mass m is resting on fixed rough inclined plane, with the help of a thread. Now the thread is burnt. Find the friction force between the sphere and the inclined plane (Given: $\mu=0.4$)



Options:

(a) 0.4 mg

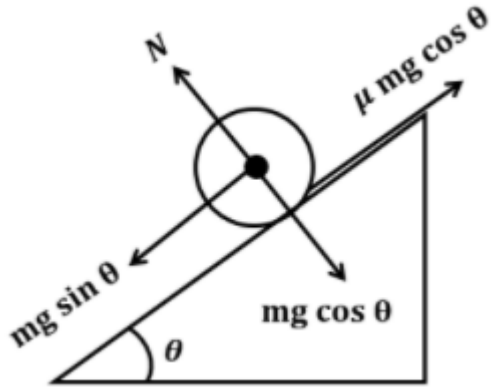
(b) $\frac{\sqrt{3}}{7}mg$

(c) 0.2 mg

(d) None of these

Answer: (c)

Solution:



$$F_g = mg\sin\theta = \frac{\sqrt{3}}{2}mg \approx 0.8mg$$

$$f = \mu mg\cos\theta = 0.4 \times mg \times \frac{1}{2} = 0.2\,mg$$

As, $F_g > f$

So, friction force 0.2 mg

Question: Find the relation between α and β of a transistor?

Options:

(a) $\beta = \frac{\alpha}{1+\alpha}$

(b) $\beta = \frac{\alpha}{1-\alpha}$

(c) $\beta = \frac{1+\alpha}{\alpha}$

(d) $\beta = \frac{1-\alpha}{\alpha}$

Answer: (b)

Solution:

$$\alpha = \frac{\Delta i_C}{\Delta i_E}$$

$$\beta = \frac{\Delta i_C}{\Delta i_B} = \frac{\Delta i_C}{\Delta i_E} \times \frac{\Delta i_E}{\Delta i_B}$$

$$= \alpha \times \frac{\Delta i_E}{\Delta i_B} \quad ....(1)$$

$$\Delta i_B = \Delta i_E - \Delta i_C \quad ...(2)$$

Substituting the equation (2) in equation (1) we get,

$$\beta = \alpha \times \frac{\Delta i_E}{\Delta i_E - \Delta i_C}$$

$$\beta = \alpha \times \frac{1}{1 - \frac{\Delta i_C}{\Delta i_E}}$$

Now, we know $\alpha = \frac{\Delta i_C}{\Delta i_E}$ Therefore, we get,

$$\beta = \frac{\alpha}{1-\alpha}$$

Question: In a series LCR circuit $X_L = 10\Omega, X_C = 4\Omega$ and $R = 6\Omega$. Find power factor?

Options:

(a) 2

(b) 1/2

(c) $\sqrt{2}$

(d) $\frac{1}{\sqrt{2}}$

Answer: (d)

Solution:

$$\cos\phi = \frac{R}{Z}$$

$$= \frac{6}{\sqrt{6^2 + (10-4)^2}}$$

$$= \frac{6}{\sqrt{36+36}}$$

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

Question: A rod of mass M and length L is bent to form a semicircle. The MOI about an axis perpendicular to the plane of semicircle about its centre is

Options:

(a) $\frac{ML^2}{12}$

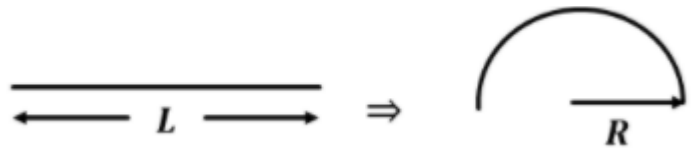
(b) $\frac{ML^2}{\pi^2}$

(c) $\frac{ML^2}{4\pi^2}$

(d) $\frac{ML^2}{2}$

Answer: (b)

Solution:



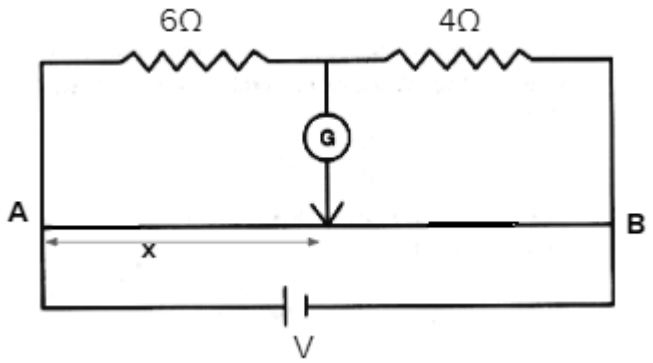
$\pi R = L$

$\boxed{R = \frac{L}{\pi}}$

$\therefore$ Moment of inertia $= MR^2$

$= \frac{ML^2}{\pi^2}$

Question: In the given set up if there is no deflection in the galvanometer then find the value of x. Total length of wire AB is 78cm

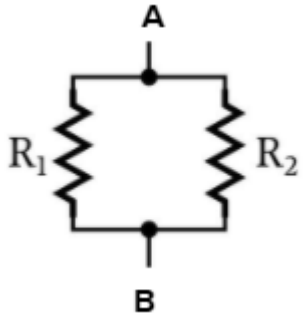


Options:

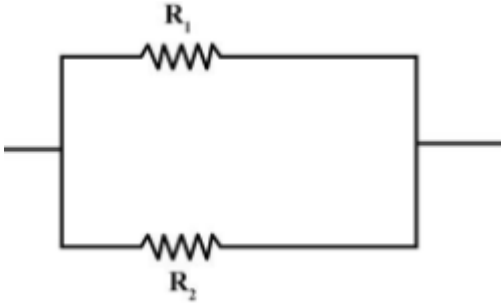
(a) 46.8 cm
(b) 31.2 cm
(c) 39 cm
(d) 50 cm
Answer: (a)
Solution:

$$\frac{x}{6}=\frac{78-x}{4}$$
$$4x=78\times 6-6x$$
$$10x=78\times 6$$
$$x=46.8\,cm$$

Question: For the given circuit determine equivalent resistivity between point A & B. R_1 and R_2 have identical geometrical dimensions and resistivity 3 & 6 respectively.



Options:
(a) 1
(b) 2
(c) 3
(d) 4
Answer: (d)
Solution:



$$R_1=\frac{3l}{A}$$
$$R_2=\frac{6l}{A}$$
$$R_{AB}=\frac{R_1R_2}{R_1+R_2}$$

$$= \frac{\left(\frac{3l}{A}\right)\left(\frac{6l}{A}\right)}{\left(\frac{3l}{A}\right)+\left(\frac{6l}{A}\right)}$$

$$\left(\frac{\rho l}{2A}\right) = \frac{2l}{A}$$

$$\boxed{\rho = 4}$$

Question: An ideal gas follows a process $pv^{\gamma} =$ constant where $\gamma =$ adiabatic exponent. The slope of $p - v$ graph will be represented by

Options:

(a) $-\gamma V / P$

(b) $-\gamma P / V$

(c) $-P / V$

(d) $-V / P$

Answer: (b)

Solution:

$PV^{\gamma} =$ Constant

$$\Rightarrow dPV^{\gamma} + \gamma PV^{\gamma-1}dV = 0$$

$$\Rightarrow \frac{dP}{dV} = \frac{-\gamma P}{V}$$

Question: A particle of mass 5 gm is thrown from the ground with a speed of $5\sqrt{2} m/s$ at an angle of 45° from the ground. Find the change in momentum from the throwing instant upto the time instant when it fell on to ground.

Options:

(a) 0.5 Ns

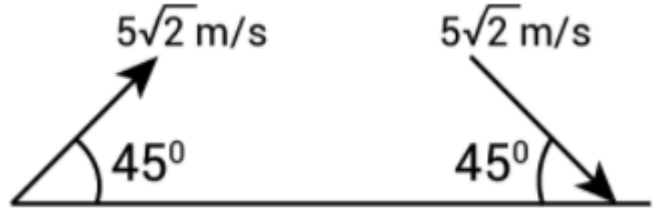
(b) 0.025 Ns

(c) 0.05 Ns

(d) 0.25 Ns

Answer: (c)

Solution:



$$\vec{P}_{\text{initial}} = m\left(5\sqrt{2}\cos 45°\hat{i} + 5\sqrt{2}\sin 45°\hat{j}\right)$$

$$\vec{P}_{\text{final}} = m\left(5\sqrt{2}\cos 45°\hat{i} - 5\sqrt{2}\sin 45°\hat{j}\right)$$

$$\Delta\vec{P} = m\left(-10\sqrt{2}\times\frac{1}{\sqrt{2}}\hat{j}\right)$$

$$\left|\Delta\vec{P}\right| = 5\times10^{-3}\times10 = 0.05\ Ns$$

Question: A comet is approaching earth with speed of 286 km/s. It is observed that the light coming from comet is shifted by $x\times10^{-10}m$ for a wavelength of 630 nm. Find x?

Options:

(a) $x = 1$

(b) $x = 30$

(c) $x = 6$

(d) $x = 100$

Answer: (c)

Solution:

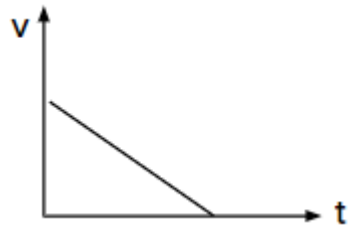
$$\lambda' = \left(1-\frac{v}{c}\right)\lambda$$

$$\Rightarrow \lambda - \lambda' = \frac{v}{c}\times\lambda = \frac{286\times10^3}{3\times10^8}\times630\times10^{-9}$$

$$\Rightarrow \lambda - \lambda' = 6.0\times10^{-10}m$$

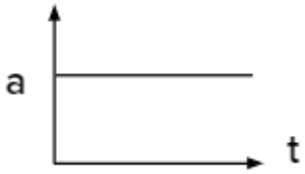
$$\Rightarrow x = 6$$

Question: From the given velocity-time (v - t) graph identify the correct acceleration - time (a - t) graph.



Options:

(a)



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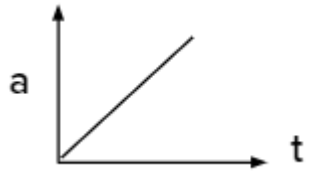
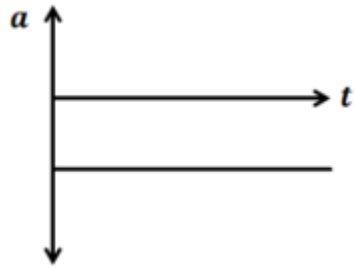
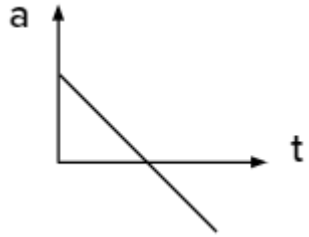


(c)



(d)



Answer: (c)

Solution:

As velocity time graph is a straight line with negative slope.

So, option 'c' is correct.

Question: There is an antenna of length 20m. If we take two cases as:-

(i) The antenna is at ground level

(ii) The antenna is at 5m above the ground level then the difference in range between the two cases in percentage in n%. Find n?

Options:

(a) 12 %

(b) 25%

(c) 35 %

(d) 40 %

Answer: (a)

Solution:

Range $(d) = \sqrt{2Rh_T}$

$d_1 = \sqrt{2R \times 20} = \sqrt{40R}$

$d_2 = \sqrt{2R(20+5)} = \sqrt{50R}$

$$\frac{\Delta d}{d_1} \times 100 = \frac{\sqrt{50R} - \sqrt{40R}}{\sqrt{40R}} = \left(\sqrt{\frac{5}{4}} - 1\right) \times 100$$

$$\frac{\Delta d}{d_1} \times 100 = 12\%$$

JEE-Main-18-03-2021-Shift-2 (Memory Based)

CHEMISTRY

Question: Two elements x and y have more ionisation energy than Mg. z have less ionisation energy than Mg. x, y, z respectively are

Options:

(a) Lithium, Argon, Sodium

(b) Neon, Chlorine, Sodium

(c) Argon, Sodium, Chlorine

(d) Lithium, Chlorine, Sodium

Answer: (b)

Solution:

Ionisation energy $\Rightarrow$ x, y > Mg

Z < Mg

Ne, Cl > Mg

Na < Mg

Question: S1: Thermal power plants produce non-biodegradable waste.

S2: Biodegradable waste lead to eutrophication

Options:

(a) Both S1 and S2 are correct

(b) S1 is correct, S2 is incorrect

(c) S2 is correct, S1 is incorrect

(d) Both S1 and S2 are incorrect

Answer: (a)

Solution: Non-biodegradable wastes are generated by thermal power plants which produces fly ash.

Eutrophication is the process in which a water body becomes overly enriched with nutrients, leading to plentiful growth of simple plant life. The excessive growth (or bloom) of algae and plankton in a water body are indicators of this process.

Question: Which is paramagnetic?

Options:

(a) Mn_3O_4

(b) MgO

(c) Na_2O

(d) SiO_2

Answer: (a)

Solution:

Mn_3O_4

Mn^{2+} Mn^{3+}

Both have unpaired electron

At room temperature, Mn_3O_4 is paramagnetic below 41-43 K, it is ferrimagnetic

Question: Ratio of V_{rms} to $V_{average}$ of O:

Options:

(a) $\frac{3\pi}{8}$

(b) $\sqrt{\frac{3\pi}{8}}$

(c) $\sqrt{\frac{3}{2}}$

(d) $\frac{3\pi}{8}$

Answer: (b)

Solution:

$$\frac{V_{rms}}{V_{av}} = \frac{\sqrt{\frac{3RT}{M}}}{\sqrt{\frac{8RT}{\pi M}}} = \sqrt{\frac{3\pi}{8}}$$

Question: The solubility of $CdSO_4$ is 8×10^{-4}. Solubility in 0.01 M H_2SO_4?

Options:

(a) 24×10^{-6}

(b) 34×10^{-6}

(c) 44×10^{-6}

(d) 64×10^{-6}

Answer: (d)

Solution:

$s = 8 \times 10^{-4}$

$Ksp = s^2 = (8 \times 10^{-4})^2 = 64 \times 10^{-8}$

In the presence of H_2SO_4 (0.01 M)

$CdSO_4 \rightleftharpoons Cd^{2+} + SO_4^{2-}$

$s \quad s + 0.01$

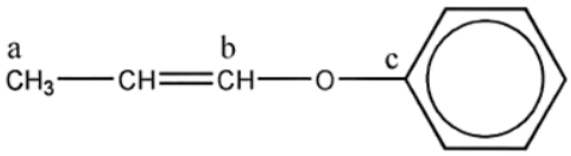
$Ksp = s \times (s + 0.01)$

$64 \times 10^{-8} = S \times 0.01 \quad [\because S + 0.01 \simeq 0.01]$

$s = 64 \times 10^{-8}$

$$s = \frac{64 \times 10^{-8}}{0.01} = 64 \times 10^{-6}$$

Question: The hybridisation of a, b and c are respectively



Options:

(a) sp^3, sp^2, sp^2

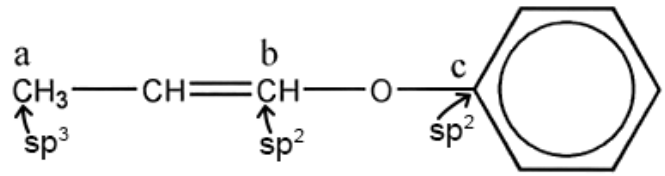
(b) sp, sp^3, sp^2

(c) sp^2, sp, sp^3

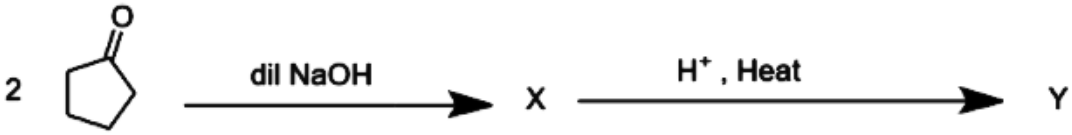
(d) sp^3, sp, sp^2

Answer: (a)

Solution:

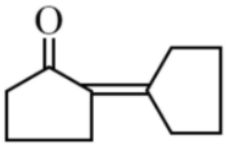


Question: What is the structure of 'Y'?

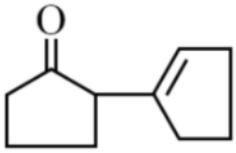


Options:

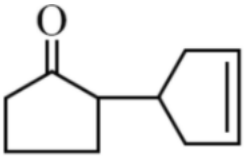
(a)



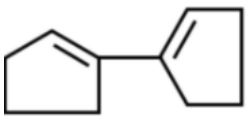
(b)



(c)

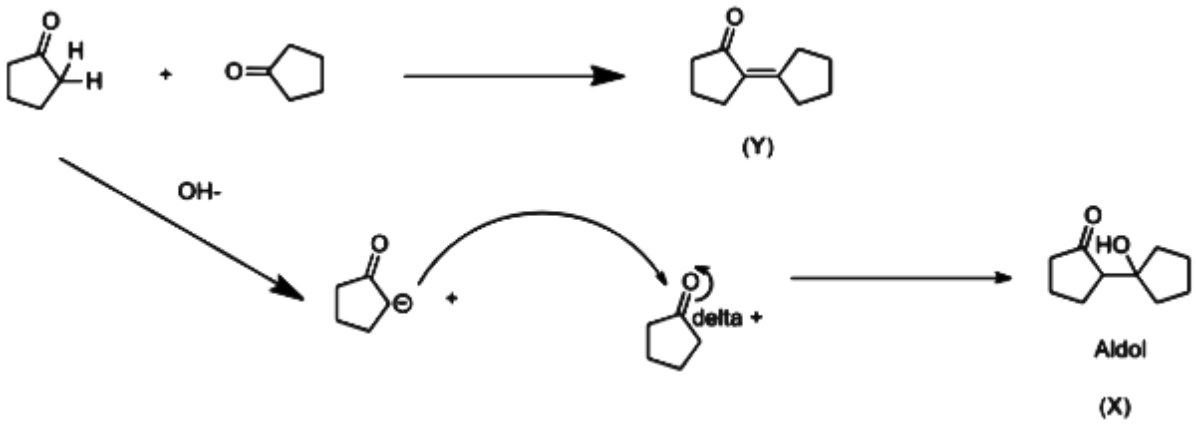


(d)



Answer: (a)

Solution:



Question: Match the following.

Column I	**Column II**
(A) Antifertility drug	**i)** Meprobamate
(B) Tranquilizer	**ii)** Norethindrone
(C) Antibiotic	**iii)** Salvarsan
(D) Artificial sweeteners	**iv)** Alitame

Options:

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

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

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

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

Answer: (a)

Solution: Antifertility drugs are chemical substances which suppress the action of hormones that promote pregnancy. These drugs actually reduce the chances of pregnancy and act as protection.

A tranquilizer refers to a drug which is designed for the treatment of anxiety, fear, tension, agitation, and disturbances of the mind, specifically to reduce states of anxiety and tension.

An antibiotic is a type of antimicrobial substance active against bacteria.

Artificial sweeteners, or sugar substitutes, are chemicals added to some foods and beverages to make them taste sweet.

Question: The charge on the colloidal sols of CdS and TiO_2 are:

Options:

(a) Positive and negative

(b) Negative and positive

(c) Positive and positive

(d) Negative and negative

Answer: (b)

Solution:

Negative charged colloids

* Metal sulphides: As_2S_3, CdS

* Metal dispersions: Ag, Au, Pt

Positive charged colloids

* Metal hydroxides: $Al(OH)_3$, $Fe(OH)_3$

* Metal oxide: TiO_2

Question: Deficiency of vitamin K causes:

Options:

(a) Cheloiosis

(b) Increase blood clotting time

(c) Decrease blood clotting time

(d) Does not affect blood clotting time

Answer: (b)

Solution: Vitamin K is important for blood clotting, bone health, and more. The main symptom of a vitamin K deficiency is excessive bleeding caused by an inability to form blood clots.

Question: H_2O_2 is used in the basic medium in which of the following reactions?

Options:

(a) $Mn^{2+} \longrightarrow Mn^{4+}$

(b) $I_2 \longrightarrow I^-$

(c) Both (a) and (b)

(d) None of these

Answer: (c)

Solution:

Oxidising action in basic medium

$2Fe^{2+} + H_2O_3 \rightarrow 2Fe^{3+} + 2OH^-$

$Mn^{2+} + H_2O_2 \rightarrow Mn^{4+} + 2OH^-$

Reducing action in basic medium

$I_2 + H_2O_2 + 2OH^- \rightarrow 2I^- + 2H_2O + O_2$

$2MnO_4^- + 3H_2O_2 \rightarrow 2MnO_2 + 3O_2 + 2H_2O + 2OH^-$

Question: An organic compound B reacts with benzene sulphonic chloride to give a compound which is soluble in alkali metal hydroxide. What is B?

Options:

(a) $(C_2H_5)_2NH$

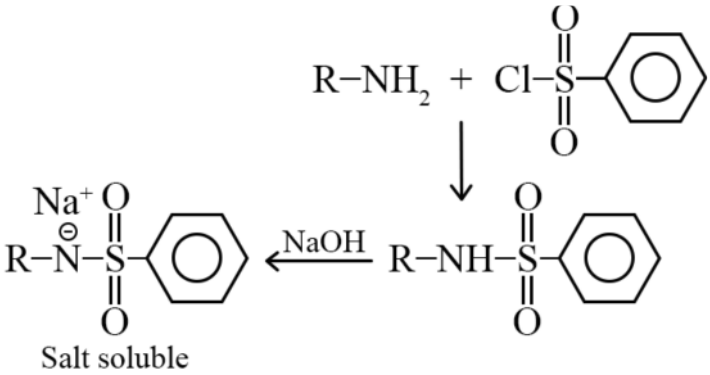
(b) $C_2H_5NH_2$

(c) $(C_2H_5)_3N$

(d) All of these

Answer: (b)

Solution:



The organic compound B is primary amine.

Question: Partial hydrolysis of A gives XeO_2F_2. Find lone pairs of A

Options:

(a) 2

(b) 1

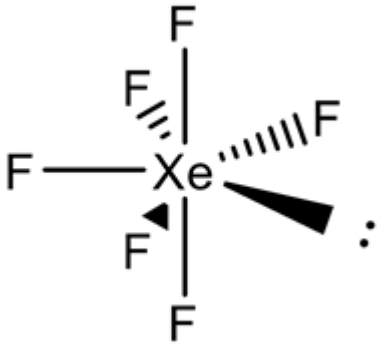
(c) 3

(d) 4

Answer: (b)

Solution:

$$XeF_6 + 2H_2O \rightarrow \underset{\text{Xenon dioxydifluoride}}{XeO_2F_2} + 4HF$$



Question: Arrange the following in the decreasing oxidation states of NO, N_2O, NO_2, NO_3^-
Options:

(a) $NO_3^- > NO_2 > NO > N_2O$

(b) $N_2O > NO_2 > NO > NO_3^-$

(c) $NO > NO_2 > N_2O > NO_3^-$

(d) $N_2O > NO_2 > NO > NO_3^-$

Answer: (a)

Solution:

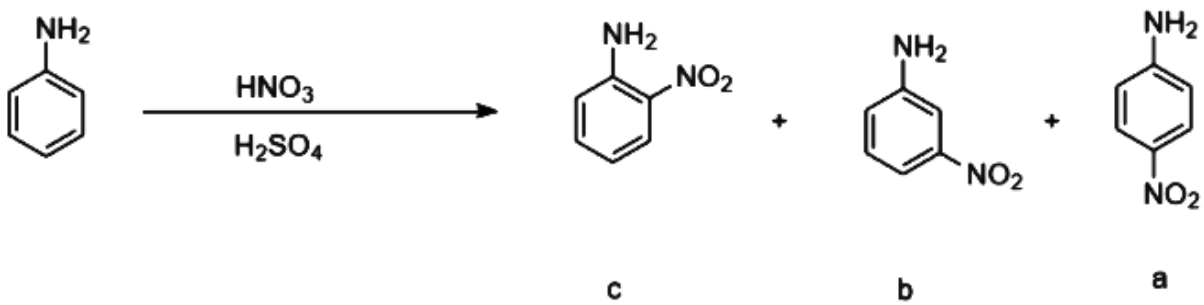
NO = +2

N_2O = +1

NO_2 = +4

NO_3^- = +5

Question:



Percent yield of a, b, c are in the order?

Options:

(a) a > c > b

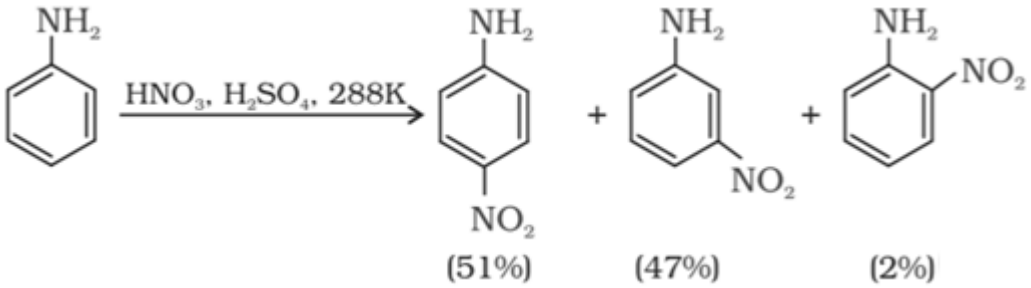
(b) a > b > c

(c) c > a > b

(d) b > a > c

Answer: (b)

Solution: Nitration: Direct nitration of aniline yields tarry oxidation products in addition to the nitro derivatives. Moreover, in the strongly acidic medium, aniline is protonated to form the anilinium ion which is meta directing. That is why besides the *ortho* and *para* derivatives, significant amount of *meta* derivative is also formed.



However, by protecting the $-NH_2$ group by acetylation reaction with acetic anhydride. The nitration reaction can be controlled and the *p*-nitro derivative can be obtained as the major product.

Question: S1: C_2H_5OH and AgCN can form nucleophile.

S2: AgCN and KCN can form nitrile nucleophile in all reaction conditions.

Options:

(a) Both S1 and S2 are correct

(b) S1 is correct, S2 is incorrect

(c) S2 is correct, S1 is incorrect

(d) Both S1 and S2 are incorrect

Answer: (b)

Solution: $C_2H_5\ddot{O}H$ itself is a nucleophile due to presence of lone pair on O-atom and AgCN can form nucleophile by forming CN^- ion. But, AgCN and KCN can form CN^- nucleophile in polar solvent not in non-polar solvent

Question: S1: Bohr's model could explain the stability and line spectrum of Li^{+}.

S2: Bohr could not explain the splitting of spectral lines in magnetic field.

Options:

(a) Both S1 and S2 are correct

(b) S1 is correct, S2 is incorrect

(c) S2 is correct, S1 is incorrect

(d) Both S1 and S2 are incorrect

Answer: (c)

Solution:

Bohr's theory was unable to explain the following observations:

i) Bohr's model could not explain the spectra of atoms containing more than one electron.

ii) It could not explain the Zeeman effect.

In presence of the magnetic field, each spectral line gets split up into fine lines, the phenomenon is known as Zeeman effect.

iii) It could not explain the Stark effect.

In presence of the electric field, each spectral line gets split up into fine lines, the phenomenon is known as the Stark effect.

iv) The main objection to Bohr's model was raised by Heisenberg's uncertainty principle.

According to Heisenberg's uncertainty principle, it is impossible to determine simultaneously the exact position and the momentum of a small moving particle like an electron.

But, according to Bohr's model electron moves in well-defined orbits around the nucleus, and hence its position, as well as momentum, can be determined simultaneously, which is against the uncertainty principle.

So, electron moves in well-defined orbits around the nucleus is impossible.

Question: A molecule dimerises in 2 molal solution. The boiling point is 100.52°C. (K_b of water = 0.52. T_b of water = 100°C). Find the percentage association.

Options:

(a) 100

(b) 90

(c) 80

(d) 70

Answer: (a)

Solution:

$\Delta T_b = imK_b$

$i = \frac{\Delta T_b}{mK_b}$

$i = \frac{0.52}{2 \times 0.52}$

$i = 0.5$

$i = \frac{2 - \alpha}{2}$

$i = 1$

α = degree of association

% association = 100%

Question: Match the following.

Column I	**Column II**
(A) Be	**i)** Cancer treatment
(B) Mg	**ii)** X ray tube window
(C) Rh	**iii)** Used in automobiles

Options:

(a) A → (ii); B → (iii); C → (i)

(b) A → (iii); B → (ii); C → (i)

(c) A → (i); B → (iii); C → (ii)

(d) A → (i); B → (ii); C → (iii)

Answer: (a)

Solution: The X-ray tube window typically is made from beryllium because it allows X-rays to pass through but has sufficient strength to hold the vacuum required for the X-ray tube to operate.

Steel, aluminium, and magnesium are all common metals used in the automotive industry

Combination of Three Metals for the Treatment of Cancer: Gallium, Rhenium and Platinum.

Question: 10 ml of Na_2CO_3 was titrated against 0.2 M HCl. The following were the titre values obtained (ml) 4.8, 4.9, 5.0, 5.0, 5.0. Molarity of Na_2CO_3 in: ?

Options:

(a) 0.25

(b) 0.45

(c) 0.05

(d) 0.01

Answer: (c)

Solution:

$1 = Na_2CO_3$, $2 = HCl$

$N_1V_1 = N_2V_2$

$2 \times M_1 \times V_1 = 1 \times M_2 \times V_2$

$$M_1 = \frac{M_2 \times V_2}{2 \times V_1}$$

$$M_1 = \frac{0.2 \times 5}{2 \times 10}$$

$M_1 = 0.05$ moles L^{-1}

Question: Half-life of a reaction is 60 second. Reaction is completed by 99.9%. Calculate the time taken for this to happen

Options:

(a) 797.6 sec

(b) 387.6 sec

(c) 697.6 sec

(d) 597.6 sec

Answer: (a)

Solution:

$$t_{1/3} = \frac{0.693}{K}$$

$$K = \frac{0.693}{60}$$

$$K = 0.01155\,\text{sec}^{-1}$$

$$t = \frac{2.303}{K} \log \frac{100}{0.01}$$

$$t = \frac{2.303}{0.01155} \log \frac{100}{0.01}$$

$$K = 797.6 \text{sec}$$

Question: In $CuSO_4$, how many water molecules bonded to complex and outside of complex

Options:

(a) 4, 1

(b) 5, 2

(c) 6, 1

(d) 6, 2

Answer: (a)

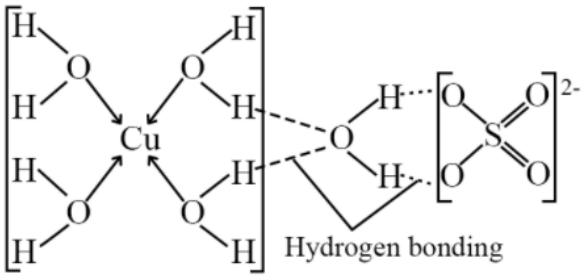
Solution:

$CuSO_4.5H_2O$

Deep blue

$4H_2O$

H_2O (Hydrogen bonding)



Question: Match the following.

Column I	**Column II**
(A) Copper	**i)** Zone refining
(B) Nickel	**ii)** Electrolytic refining
(C) Silicon	**iii)** Vapour phase refining
(D) Aluminium	**iv)** Hall Heroult process

Options:

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

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

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

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

Answer: (a)

Solution:

Copper ⇒ Electrolytic refining

Nickel ⇒ Vapour phase refining

Silicon ⇒ Zone refining

Aluminium ⇒ Hall Heroult process

JEE-Main-18-03-2021-Shift-2 (Memory Based)

MATHEMATICS

Question: If S_1 is the sum of first 2n terms and S_2 is the sum of first 4n term and $S_1 - S_2$ is equal to 1000 then S_3 sum of first 6n terms of same A.P

Options:

(a) 3000

(b) 5000

(c) 7000

(d) 9000

Answer: (a)

Solution:

$$S_1 = \frac{2n}{2}\left(2a + (2n-1)d\right)$$

$$= 2an + 2n^2d - nd$$

$$S_2 = \frac{4n}{2}\left(2a + (4n-1)d\right)$$

$$= 4an + 8n^2d - 2nd$$

$$S_2 - S_1 = 2an + 6n^2d - nd = 1000$$

$$S_3 = \frac{6n}{2}\left(2a + (6n-1)d\right)$$

$$= 3n \cdot 2a + 18n^2d - 3nd$$

$$= 3\left(S_2 - S_1\right)$$

$$= 3 \times 1000$$

$$= 3000$$

Question: $\bar{a}$ and $\vec{b}$ are perpendicular UNIT vectors such that $\left|\bar{a}\right| = \left|\bar{b}\right|$, Angle between $\bar{a} + \bar{b} + \left(\bar{a} \times \bar{b}\right)$ and $\bar{a}$

Options:

(a)

(b)

(c)

(d)

Answer: ()

Solution:

Let $\vec{a}, \vec{b}$ be $\hat{i}, \hat{j}$

$$\Rightarrow \hat{i}+\hat{j}+\left(\hat{i}\times\hat{j}\right)$$

$$\vec{u}=\hat{i}+\hat{j}+\hat{k} \quad \& \quad \hat{i}=\vec{v}$$

$$\cos\theta=\frac{\vec{u}\cdot\vec{v}}{|\vec{u}||\vec{v}|}=\frac{1}{\sqrt{3}.1}$$

Question: There are 5 independent trials, probability of exactly one success is = 4096, probability of exactly 2 success = 0.2048. Find probability of exactly 3 success.

Options:

(a)

(b)

(c)

(d)

Answer: ()

Solution:

$${}^{5}C_{1}p\left(1-p\right)^{4}=0.4096 \qquad ....(1)$$

$${}^{5}C_{2}p^{2}\left(1-p\right)^{3}=0.2048 \qquad ....(2)$$

Divide (1) by (2)

$$\frac{5p\left(1-p\right)^{4}}{10p^{2}\left(1-p\right)^{3}}=\frac{4096}{2048}$$

$$4p=1-p$$

$$p=\frac{1}{5}$$

$$p\left(3\right)={}^{5}C_{3}p^{3}\left(1-p\right)^{2}=\frac{5\times4\times3}{3\times2}\cdot\frac{1}{3}\cdot\frac{1}{5}\cdot\frac{1}{5}\cdot\frac{4}{5}\cdot\frac{4}{5}=\frac{32}{625}$$

Question: $P\left(x\right)$ is polynomial such that $P\left(x\right)=f\left(x^{3}\right)+xg\left(x^{3}\right)$, $P\left(x\right)$ is divided by $x^{2}+x+1$

Options:

(a)

(b)

(c)

(d)

Answer: ()

Solution:

x^2+x+1 has roots ω, ω^2

$\Rightarrow p(\theta)=p(\omega^2)=0$

$\Rightarrow f(\omega^3)+\omega(g(\omega^3))=0$

$f(1)+\omega g(1)=0 \quad ...(1)$

Similarly $f(\omega^6)+\omega^2(g(\omega^6))=0$

$f(1)+\omega^2 g(1)=0 \quad ...(2)$

(1) + (2)

$2f(1)+(\omega+\omega^2)g(1)=0$

$2f(1)-g(1)=0$

(1) – (2)

$(\omega-\omega^2)g(1)=0$

$\Rightarrow g(1)=0$

Question: Which of the following tautology?

Options:

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

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

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

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

Answer: (d)

Solution:

p	q	$\sim q$	$p\rightarrow q$	$p\rightarrow q\wedge\sim q$
F	T	T	T	T
F	F	F	T	F
T	F	T	F	F
T	T	F	T	F

Question: $\frac{x^2}{27}+y^2=1,$ Tangent is drawn at $\left(3\sqrt{3}\cos\theta,\sin\theta\right).$ If meet x – axis and y – axis at A and B. Minimum value of sum of intercepts is at $\theta=$

Options:

(a) $\frac{\pi}{6}$

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

(c) $\frac{\pi}{8}$

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

Answer: (a)

Solution:

Given tangent is drawn at $\left(3\sqrt{3}\cos\theta,\sin\theta\right)$ to $\frac{x^2}{27}+y^2=1$

Eg of $T:\frac{x\cos\theta}{3\sqrt{3}}+\frac{y\sin\theta}{1}=1$

Sum of intercepts = $f\left(\theta\right)=3\sqrt{3}\sec\theta+\operatorname{cosec}\theta$

$$f'\left(\theta\right)=\frac{3\sqrt{3}\sin^3\theta-\cos^3\theta}{\sin^2\theta\cos^2\theta}$$

$$3\sqrt{3}\sin^3\theta=\cos^3\theta$$

$$\sin^3\theta=\frac{1}{3^{3/2}}\cos^3\theta$$

$$\tan\theta=\frac{1}{\sqrt{3}}$$

$$\theta=\frac{\pi}{6}$$

Question: One side of equilateral Δ is $x+y=3,$ centroid is $\left(0,0\right),r=R=$

Options:

(a)

(b)

(c)

(d)

Answer: ()

Solution:

One vertex be (h, k)

Centroid is (0, 0)

(a, b) lies on $x+y=3$

$a+b-3=0$

$\frac{2a+h}{3}=0, \frac{2b+k}{3}=0$

$h=-2a, \quad k=-2b$

$\frac{h-a}{k-b}(-1)=-1$

$b-a=k-b$

$a+b=3$

$\frac{-h}{2}-\frac{k}{2}-3=0$

$h+k+6=0$

$h=k=3$

$\therefore (0,0)\ R\ (-3,-3)$

$\Rightarrow R=3\sqrt{2}$

$r=(0,0) \perp \text{dist}\ \ x+y=3$

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

$r+R=3\sqrt{2}+\frac{3}{\sqrt{2}}=\frac{9}{\sqrt{2}}$

Question: 10, 7, 8 are sides of Δ. Find projection side of length '10' on '7'.

Options:

(a)

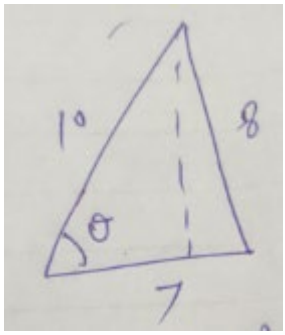
(b)

(c)

(d)

Answer: ()

Solution:



$$10\cos\theta = 10\times\frac{10^2+7^2-8^2}{2\times10\times7}$$
$$= 10\times\frac{149-64}{2\times10\times7}$$
$$= \frac{85}{14}$$

Question: $15\sin^4\alpha + 10\cos^4\alpha = 6, 27\sec^6\alpha + 8\operatorname{cosec}^6\alpha =$

Options:

(a)

(b)

(c)

(d)

Answer: ()

Solution:

$$10\left(\sin^4\alpha + \cos^4\alpha\right) + 5\cos^4\alpha = 6$$

$$10 - 20\sin^2\alpha\cos^2\alpha + 5\cos^4\alpha = 6$$

$$4 - 20\sin^2\alpha\cos^2\alpha = -5\cos^4\alpha$$

$$4\sec^4\alpha - 20\tan^2\alpha = -5$$

$$\Rightarrow 20\tan^2\alpha - 4\sec^4\alpha - 5 = 0$$

$$20\tan^2\alpha - 4\left(1+\tan^2\alpha\right)^2 - 5 = 0$$

$$20\tan^2\alpha - 4\left(1+\tan^4\alpha + 2\tan^2\alpha\right) - 5 = 0$$

$$\tan^4\alpha - 3\tan^2\alpha + \frac{9}{4} = 0$$

$$\Rightarrow \tan^2\alpha = \frac{3}{2}$$

$$\tan\alpha = \frac{\sqrt{3}}{\sqrt{2}}$$

Question: $\left(\frac{x+1}{x^{\frac{2}{3}}-x^{\frac{1}{3}}+1}-\frac{x-1}{x+x^{\frac{1}{2}}}\right)^{10}$, find term independent of 'x'

Answer: 4.00

Solution:

$$\left(\frac{\left(x^{1/3}\right)^3+\left(1^{1/3}\right)^3}{x^{2/3}-x^{1/3}+1}-\frac{\left(\sqrt{x}-1\right)\left(\sqrt{x}+1\right)}{\sqrt{x}\left(\sqrt{x}+1\right)}\right)$$

$$\left(\frac{\left(x^{1/3}+1\right)\left(x^{2/3}+1-x^{1/3}\right)}{\left(x^{2/3}-x^{1/3}+1\right)}-1+x^{-1/2}\right)^{10}$$

$$\left(x^{1/3}+x^{-1/2}\right)10$$

$$T_{r+1}={}^{10}C_r\times\frac{10-r}{3}\times\frac{-r}{2}$$

$$\frac{10-r}{3}-\frac{r}{2}=0$$

$$20-2r-3r=0$$

$$20=5r$$

$$r=4$$

Question: Out of 2n terms: n terms are 'a' and rest are '-a'. If we add 'b' to all the terms than mean = 5 and standard deviation = 20 then $a^2+b^2=?$

Answer: 425.00

Solution:

$$\frac{na-na+2nb}{2n}=5$$

$$b=5$$

Variance = 400

$$400=\left(a+b-5\right)^2$$

$$400=\frac{1}{2}\left(a^2+a^2\right)\qquad\because b=5$$

$$800=2a^2$$

$$a=20$$

$a^2 + b^2 = 425$

Question: $xdy - ydx = \sqrt{x^2 - y^2}\ dx,\ y(1) = 0,$ area between curve and x – axis for $x \in \left[1, e^{\pi}\right]$ is $ae^{2\pi} + b,$ then $10(a+b)$ equal to

Answer: 4.00

Solution:

$$x\,dy - y\,dx = \sqrt{x^2 - y^2}\,dx$$

$$\frac{x\,dy - y\,dx}{x^2} = \frac{\sqrt{1 - \frac{y^2}{x^2}}}{x}dx$$

$$\frac{d\left(\frac{y}{x}\right)}{\sqrt{1 - \left(\frac{y}{x}\right)^2}} = \frac{dx}{x}$$

$$\sin^{-1}\frac{y}{x} = \ln x + c$$

$$x = 1,\ y = 0 \Rightarrow 0 = 0 + c$$

$$c = 0$$

$$\frac{\sin^{-1} y}{x} = \ln x \Rightarrow y = x \sin \ln x$$

$$\text{Area} = \int_1^{e\pi} x \sin\left(\ln x\right) dx$$

$$I = \frac{x^2}{2}\sin\left(\ln x\right) - \int \frac{\cos \ln x}{x} \cdot \frac{x^2}{2}$$

$$I = \frac{x^2}{2}\sin\left(\ln x\right) - \frac{1}{2}\left(\frac{x^2}{2}\cos \ln x + \int \frac{x^2}{2}\frac{\sin \ln x}{x}\right)$$

$$I = \frac{x^2}{2}\sin\left(\ln x\right) - \frac{x^2}{2}\cos \ln x - \frac{x \sin \ln x}{2}$$

$$\frac{5}{4}I = \frac{x^2}{2}\sin \ln x - \frac{x^2}{2 \cdot 2}\cos \ln x$$

$$I = \frac{x^2}{5}\left(2\sin\ln x - \cos\ln x\right)\Big|_1^{e^\pi}$$

$$= \frac{e^{2\pi}+1}{5}$$

$$\Rightarrow a = b = \frac{1}{5}$$

$$10(a+b) = 10\cdot\frac{2}{5} = 4$$

Question: $f : R \to R$ defined by $f(x).f(y) = f(x+y)\ \forall\ x, y \in R$ and $f(x) \neq 0$ for $x \in R$ f is differentiable at $x = 0,$ and $f'(0) = 0$ then $\lim\limits_{h\to 0}\frac{1}{h}\left[f(h)-1\right] =$

Answer: 3.00

Solution:

$x = 0 = y$

$f(0)^2 = f(0)$

$\Rightarrow f(0) - 0{,}1$

$f(x) \neq 0$

$\Rightarrow f(0) = 1$

$\lim\limits_{h\to 0}\dfrac{f(b)-1}{h} \Rightarrow \dfrac{0}{0}$ form

LHR

$$\Rightarrow \lim_{h\to 0}\frac{f'(h)}{1} = f'(0) = 3$$

Question: $f(x) = \dfrac{x-2}{x-3}$ and $g(x) = 2x-3,\ f^{-1}(x) + g^{-1}(x) = \dfrac{13}{2},$ Find sum of all possible values of 'x'.

Answer: 5.00

Solution:

$yx - 3y = x - 2$

$3y - 2 = x(y-1)$

$$x = \frac{3y-2}{y-1}$$

$$f^{-1}(x)+g^{-1}(x)=\frac{13}{2}$$

$$\frac{3x-2}{x-1}+\frac{3+x}{2}=\frac{13}{2}$$

$$6x-4+(3+x)(x-1)=13x-13$$

$$6x-4+3x-3+x^2-x=13x-13$$

$$x^2-5x+6=0$$

$$x=2,3$$

Sum = 5