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JEE-Main-27-08-2021-Shift-1 (Memory Based)

PHYSICS

Question: Two persons X and Y are moving towards each other with speeds of 36 km/ hr and 72 km/ hr. Y hears the sound of frequency 1320 Hz from X. What is the actual frequency?

Options:

(a) 1400 Hz

(b) 1440 Hz

(c) 1210 Hz

(d) 1300 Hz

Answer: (c)

Solution:

X is source and Y is the observer.

$v_s = 36km/h = 10m/s, v_o = -72km/h = -20m/s,$

$$f_0\left(\frac{v-(-v_0)}{v-v_s}\right) = f'$$

$$f_0\left(\frac{340+20}{340-10}\right) = 1320$$

$$\Rightarrow f_o = 1320 \times \frac{33}{36}$$

$$\Rightarrow f_o = 1210Hz$$

Question: Equation of a wave is given by: $Y = A\sin\left(500x - 10^{11}t\right)$. Find velocity of wave in the
medium (in terms of C), where C is speed of light.

Options:

(a) C

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

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

(d) $\frac{C}{2}$

Answer: (c)

Solution:

$y = a\sin(kx - \omega t)$; wave equation

$Y = A\sin\left(500x - 10^{11}t\right)$; given wave

$k = 500, \omega = 10^{11}$ (in proper units)

Now, wave velocity; $v = \frac{\omega}{k} = \frac{10^{11}}{500} = 2\times10^{8}\, m/s$

We know $c = 3\times10^{8}\, m/s$

$\Rightarrow v = \frac{2}{3}c$

Question: If E and H represents electric field and magnetizing intensity respectively, what is the dimensional formula of $\frac{E}{H}$.

Options:

(a) $\left[ML^2T^{-3}A^{-2}\right]$

(b) $\left[MLT^{-2}A^{-2}\right]$

(c) $\left[ML^2T^{-2}A^{-2}\right]$

(d) $\left[M^0L^0T^0A^0\right]$

Answer: (a)

Solution:

$[E] = \frac{[V]}{[L]}$;

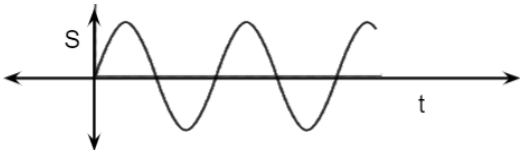
$H = \frac{B}{\mu_0}$; unit $= A/m \Rightarrow [H] = \frac{[I]}{[L]}$

$\frac{[E]}{[H]} = \frac{[V]/[L]}{[I]/[L]} = \frac{[V]}{[I]}$

But, $V = W/q$ and $q = It$

$\frac{[E]}{[H]} = \frac{[V]}{[I]} = \frac{[W]}{\left[I^2\right][t]} = \frac{ML^2T^{-2}}{A^2T} = ML^2T^{-3}A^{-2}$

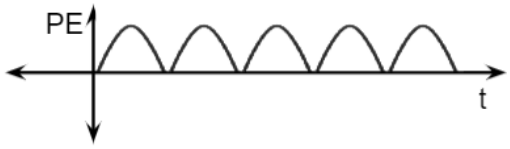
Question: From the given displacement time (s - t) graph; choose the correct PE vs t graph.



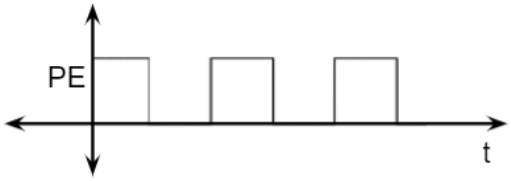
Options:

(a)

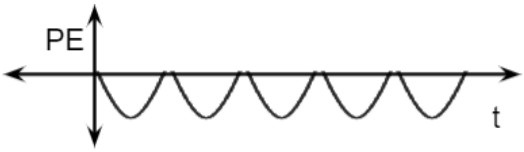
(b)



(c)



(d)



Answer: (b)

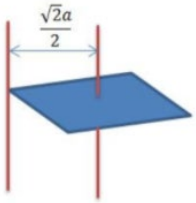
Solution:

U (Potential Energy) is maximum when displacement is maximum (A or - A).

U = 0 for displacement = 0)

This is shown by graph in option (b)

Question: Find moment of inertia of a square plate (mass M, side length L) about an axis passing through one of its corner and perpendicular to the plane.



Options:

(a) $\frac{ML^2}{3}$

(b) $\frac{2ML^2}{3}$

(c) $\frac{ML^2}{6}$

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

Answer: (b)

Solution:

MI. of a square plate about its center and $\perp$ to its plane is $\frac{1}{6}mL^2$

Here length of diagonal is $\frac{\sqrt{2}}{2}L$

Distance of area's from center is $\frac{\sqrt{2}}{2}L$

Using parallel axis theorem

$$I' = \frac{1}{6}mL^2 + m\left(\frac{\sqrt{2}L}{2}\right)^2$$

$$= \frac{2}{3}mL^2$$

Question: The pressure and temperature of an ideal gas are related as $PT^3 =$ constant. The coefficient of volume expansion of the gas is?

Options:

(a) 4/T

(b) 2/T

(c) 1/T

(d) T/4

Answer: (a)

Solution:

$PT^3 =$ constant

$PV = nRT$

$$\Rightarrow P = \frac{nRT}{V}$$

$$\therefore \frac{nRT^4}{V} = \text{constant}...(1)$$

$$\therefore r = \frac{1}{V}\frac{dV}{dT}$$

From (1) $T^4V^{-1} =$ constant

Differentiating

$$T^4(-1)V^{-2}dV + V^{-1}4T^3dT = 0$$

$$\Rightarrow \frac{4T^3}{V}dT = \frac{T^4}{V^2}dV$$

$$\Rightarrow \frac{1}{V}\left(\frac{dV}{dT}\right) = \frac{4T^3}{T^4} = \frac{4}{T}$$

$$\therefore \gamma = \frac{4}{T}$$

Question: An uniformly charged disc $\left(\sigma C/m^2\right)$ is placed in xy plane. What is the electric field at a point B at a distance z?

Options:

(a) $\frac{\sigma}{2\varepsilon_o}\left(1-\frac{z}{\sqrt{z^2+R^2}}\right)$

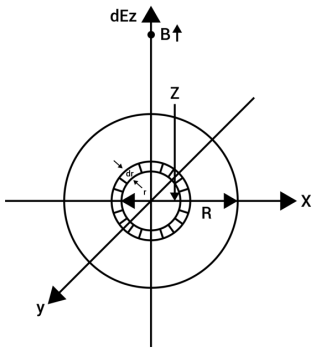
(b) $\frac{\sigma}{2\varepsilon_0}\left(1-\frac{R}{\sqrt{z^2+R^2}}\right)$

(c) $\frac{\sigma}{2\varepsilon_0}\left(1+\frac{z}{\sqrt{z^2+R^2}}\right)$

(d) $\frac{\sigma}{2\varepsilon_o}\left(1+\frac{R}{\sqrt{z^2+R^2}}\right)$

Answer: (a)

Solution:



Consider a small ring of radius 'r' and thickness 'dr' on the disc.

Area of ring $(dA)=2\pi rdr$

charge on ring $(dq)=\sigma 2\pi rdr$

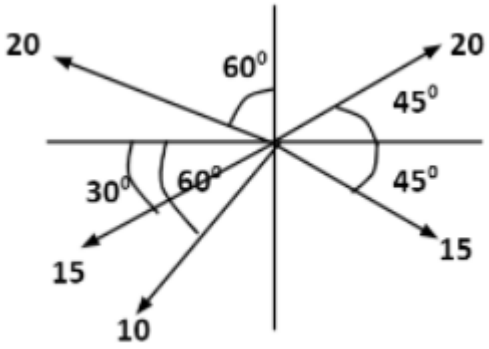
Electric field in horizontal direction will be zero because of symmetry. Only vertical component will remain.

$$dE_z=\frac{Kdqz}{\left(z^2+r^2\right)^{3/2}}=\frac{Kz(2\pi rdr)}{\left(z^2+r^2\right)^{3/2}}$$

Integrate from O to R, we get

$$E=\frac{\sigma}{2\epsilon_0}\left[1-\frac{1}{\sqrt{\frac{R^2}{z^2}+1}}\right]=\frac{\sigma}{2\epsilon_0}\left[1-\frac{z}{\sqrt{R^2+z^2}}\right]$$

Question: From the given diagram. Find the resultant of forces.



Options:

(a) $-10.56\hat{i}-2.624\hat{j}$

(b) $10.56\hat{i}+2.624\hat{j}$

(c) $10.56\hat{i}-2.624\hat{j}$

(d) $-10.56\hat{i}+4.624\hat{j}$

Answer: (a)

Solution:

Net force in x-direction:

$F_x = 20\cos 45^\circ + 15\cos 45 - 20\sin 60^\circ - 15\cos 30^\circ - 10\cos 60^\circ$

$= \frac{20}{\sqrt{2}} + \frac{15}{\sqrt{2}} - 20\frac{\sqrt{3}}{2} - 15\frac{\sqrt{3}}{2} - \frac{10}{2}$

$= 14.18 + 10.63 - 17.3 - 12.975 - 5$

≈ -10.561

Parallel $y, F_y = 20\sin 45 + 20\cos 60^\circ - 15\sin 45^\circ - 10\sin 60^\circ - 15\sin 30^\circ$

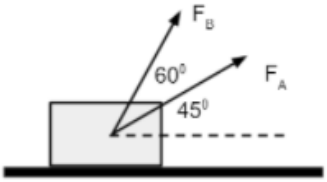
$= \frac{20}{\sqrt{2}} + \frac{20}{2} - \frac{15}{\sqrt{2}} - \frac{10\sqrt{3}}{2} - \frac{15}{2}$

$= 14.18 + 10 - 10.63 - 8.65 - 7.5$

$= -2.624$

$\therefore \vec{F} = -10.50\hat{i} - 2.624\hat{j}$

Question: If block displaces right & work done by both forces is equal; find $\frac{F_A}{F_B} = ?$



Options:

(a) $\sqrt{2}$

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

(c) 1

(d) Not possible

Answer: (b)

Solution:

Work done is same for both forces then Let's assume block moves a distance 'x'

$\therefore \left(F_B \cos 60^\circ\right)(x) = \left(F_A \cos 45^\circ\right)(x)$

$$\Rightarrow \frac{F_B}{F_A} = \frac{\cos 45^\circ}{\cos 60^\circ} = \frac{\frac{1}{\sqrt{2}}}{1/2} = \frac{2}{\sqrt{2}} = \sqrt{2}$$

$$\therefore \frac{F_A}{F_B} = \frac{1}{\sqrt{2}}$$

Question: Find identical cells each of internal resistance r $(r = 1\Omega)$ are first connected in parallel and then in series. In both cases an external resistance R is used. If current flow in both cases is same. Find R.

Options:

(a) 1Ω

(b) 2Ω

(c) 3Ω

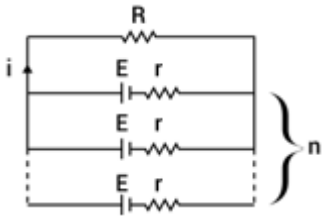
(d) 4Ω

Answer: (a)

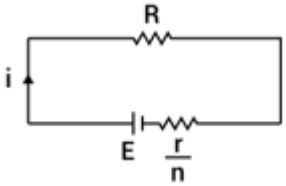
Solution:

Case I

When they connected in parallel.



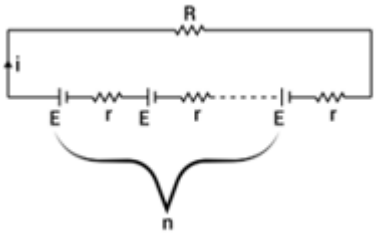
Equivalent circuit



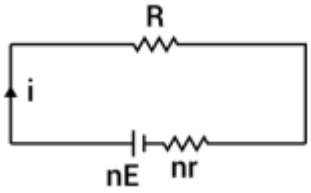
$$i = \frac{E}{R + \frac{r}{n}} \quad \text{----(i)}$$

Case-II

When they connected in series



Equivalent circuit



$i = \dfrac{nE}{R+nr}$ -----(ii)

From equation (i) and (ii)

$$\frac{nE}{nR+r} = \frac{nE}{R+nr}$$

$$R+nr = nR+r$$

$$(n-1)r = (n-1)R$$

$$R = r = 1\Omega$$

Question: If $i = \sqrt{42}\sin\left(\dfrac{4\pi t}{T}\right)+10$. Find i_{rms}.

Options:

(a) $\sqrt{42}+10$

(b) $\sqrt{21}+10$

(c) 11

(d) 31

Answer: (c)

Solution:

$$i = \sqrt{42}\sin\left(\frac{4\pi t}{T}\right)+10$$

$$i_{rms}^2 = \frac{1}{T}\int_0^T i^2 dt$$

$$= \frac{1}{T}\int_0^T \left(\sqrt{42}\sin\left(\frac{4\pi t}{T}\right)+10\right)^2 dt$$

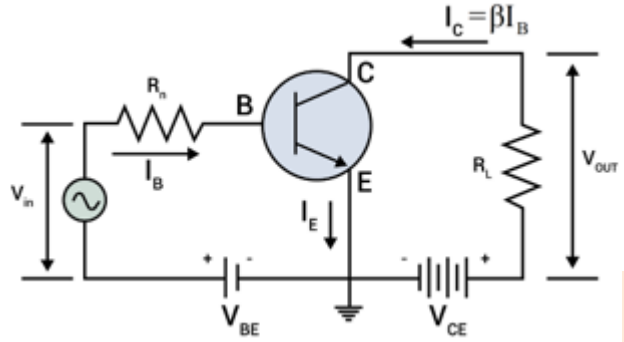
$$= \frac{1}{T}\left\{\int_0^T 42\sin^2\left(\frac{4\pi}{T}t\right)d\ell + \int_0^T 100dt + \int_0^T 20\sqrt{42}\sin\left(\frac{4\pi t}{T}\right)dt\right\}$$

$$= \frac{1}{T}\{21T+100T+0\}$$

$i_{rms}^2 = 121$

$i_{rms} = 11$

Question: A transistor is used as an amplifier in common emitter mode, the biasing is?



Options:

(a) Saturated

(b) Active

(c) Cut-off

(d) Forward

Answer: (b)

Solution:

From figure.

$I_C = \beta I_B$

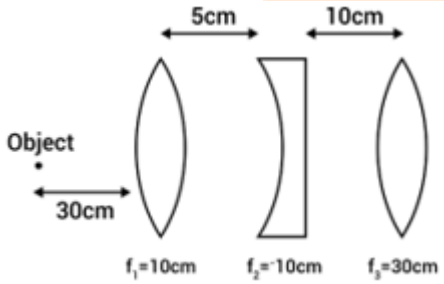
We know when the transistor is in the active state when $I_C = \beta I_B$

In Cut-off $I_B = 0, I_C = 0, I_E = 0$

In saturated:- $I_C = I_E$

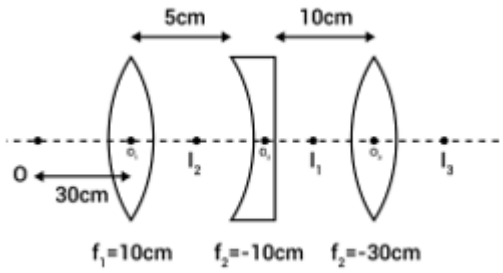
Answer B is correct

Question: Find the distance of the final image from first lens?



Answer: (23.57 cm)

Solution:



For first lens

$$\frac{1}{f_1}=\frac{1}{u_1}+\frac{1}{v_1}$$

$$\frac{1}{10}=\frac{1}{-30}+\frac{1}{v_1}$$

$$\frac{1}{v_1}=\frac{1}{10}+\frac{1}{30}$$

$$v_1=\frac{30}{4}$$

$$v_1=7.5cm$$

$$v_1=O_1I_1$$

$$O_2I_1=O_1I_1-5cm$$

$$=7.5cm-5cm$$

$$O_2I_1=2.5cm$$

$$u_2=+2.5cm$$

For second lens

$$\frac{1}{-10}=\frac{1}{2.5}+\frac{1}{v_2}$$

$$\frac{1}{v_2}=-\frac{1}{10}-\frac{2}{5}$$

$$\frac{1}{v_2}=-\frac{5}{10}$$

$$v_2=-2cm$$

$$O_2I_2=V_2=-2cm$$

For third lens

$$u_3=O_3I_2=-(10+2)=-12cm$$

$$f_3=30cm$$

$$\frac{1}{30}=\frac{1}{-12}+\frac{1}{v_3}$$

$$\frac{1}{v_3}=\frac{1}{30}+\frac{1}{12}$$

$v_3 = \frac{60}{7} cm$

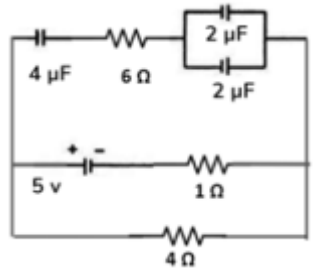
$v_3 = 8.57 cm$

Distance of the final Image from first lens

$= 5 + 10 + 8.57$

$= 23.57 cm$

Question: Find change of $4\mu F$ capacitor in steady state.



Options:

(a) $4\mu C$

(b) $6\mu C$

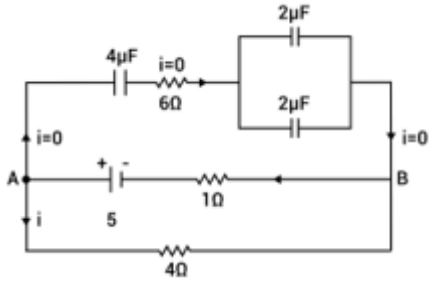
(c) $8\mu C$

(d) $10\mu C$

Answer: (c)

Solution:

At steady state



$i = \frac{5}{5} 1A$

$V_{AB} = 5 - 1 \times 1 = 4V$

At steady state voltage across

$4\mu F$ capacitor = 2V

$Q = CV$

$Q = 4 \times 2 = 8\mu C$

Question: Which of the following is not dimensions less

Options:

(a) μ (coefficient of friction)

(b) quality factor
(c) power factor
(d) ε_0 (permittivity of free space)

Answer: (d)

Solution:

(1) $\mu = \frac{f}{N}$;f and N both have dimension of force. Hence, μ is dimensionless.

(2) $Q = \frac{\text{energy stored}}{\text{energy dissipated per cycle}}$,

Q is also dimensionless.

(3) Power factor is $\cos\phi$, which is also dimensionless.

(4) ε_0 is permittivity of free space is not dimensionless.

$[\varepsilon_0] = [ML^3T^{-4}A^2]$

Question: If the intensity of light is increased for the same color?

Options:

(a) Frequency will increase
(b) No. of photons will increase
(c) Kinetic energy of photoelectrons will increase
(d) Momentum will increase

Answer: (b)

Solution:

Number of photon $\propto$ Intensity of light

Hence, if intensity of light is increased then no. of photons will increase.

Question: A uniform wire is of length **24a**. It is first bent to form an equilateral triangle of side length **a** and connected to a battery. The magnetic moment was M_1. Now the wire is bent to form a square of side length **a** and connected to the same battery. The magnetic moment was M_2. Find the ratio of M_1 and M_2.

Options:

(a) 1
(b) $\sqrt{3}$
(c) $\frac{1}{3}$
(d) $\frac{1}{\sqrt{3}}$

Answer: (d)

Solution:

Length of wire = 24 a

Perimeter of equilateral triangle of the side **a** = 3a

n $\rightarrow$ number of turns in triangle

n = 8

Perimeter of square of side a is = 4a

n' $\rightarrow$ no. of turn in square

$$n' = \frac{24a}{4a} = 6$$

Now, $M_1 = nIA = 8 \times i \times \frac{\sqrt{3}}{4} a^2$

$$M_2 = nIA = 6 \times i \times a^2$$

$$\frac{M_1}{M_2} = \frac{8 \times i \times \sqrt{3}/4 \times a^2}{6 \times i \times a^2} = \frac{\sqrt{3}}{3} = \frac{1}{\sqrt{3}}$$

Question: The height of transmitting tower is 320 m and the height of receiving tower is 2000 m. The distance between then so that there is no hindrance in communication is – (in km)

Options:

(a)160

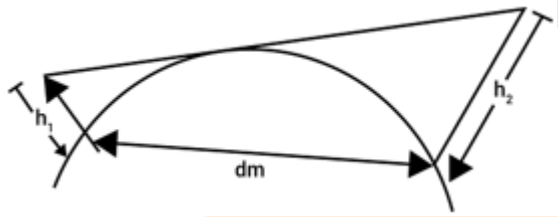
(b) 64

(c) 224

(d) 248

Answer: (c)

Solution:



Here dm stands as d minimum

distance $= \sqrt{2h_1R} + \sqrt{2h_2R}$

$d_m = \sqrt{2 \times .320 \times 6.4 \times 10^{+r}} + \sqrt{2 \times 2000 \times 6.4 \times 10^{+6}}$

$= 8 \times 8 \times 10^{+3} + 2 \times 8 \times 10^3 \times 10$

$= 64 + 160 \times 10^3$

$= 224 \times 10^3 m$

$= 224 km$

Question: An object is placed at a distance D_1 from centre of curvature of a concave mirror, away from the mirror. Its image is formed at a distance D_2 from centre of curvature towards the mirror. Find Radius of curvature of the mirror.

Options:

(a) $\frac{2D_1D_2}{D_1 - D_2}$

(b) $\frac{D_1 D_2}{D_1 - D_2}$

(c) $\frac{2D_1 D_2}{D_1 + D_2}$

(d) $\frac{D_1 D_2}{D_1 + D_2}$

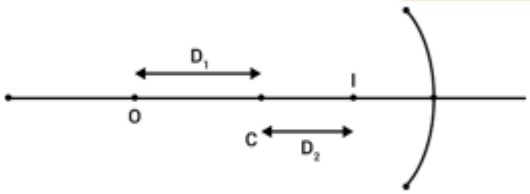
Answer: (a)

Solution:

Given

$v = -D_2 + R$

$u = +D_1 + R$



$$\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$$

$$-\frac{2}{R} = \frac{1}{-(R - D_2)} + \frac{1}{-(R + D_1)}$$

$$\frac{2}{R} = \frac{1}{(R - D_2)} + \frac{1}{R + D_1}$$

$$\frac{2}{R} = \frac{R + D_1 + R - D_2}{(R - D_2)(R + D_1)}$$

$$2\left(R^2 - D_2 R + D_1 R - D_1 D_2\right) = 2R^2 + D_1 R - D_2 R$$

$$2R^2 - 2D_2 R + 2D_1 R - 2D_1 D_2 = 2R^2 + D_1 R - D_2 R$$

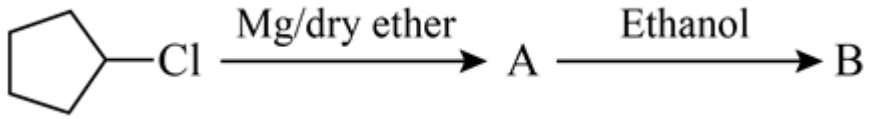
$$D_1 R - D_2 R = 2D_1 D_2$$

$$R = \frac{2D_1 D_2}{D_1 - D_2}$$

JEE-Main-27-08-2021-Shift-1 (Memory Based)

CHEMISTRY

Question: Identify 'B' in the following reaction

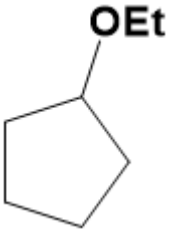


Options:

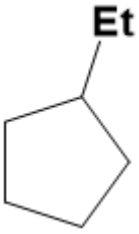
(a)

(b)

(c)

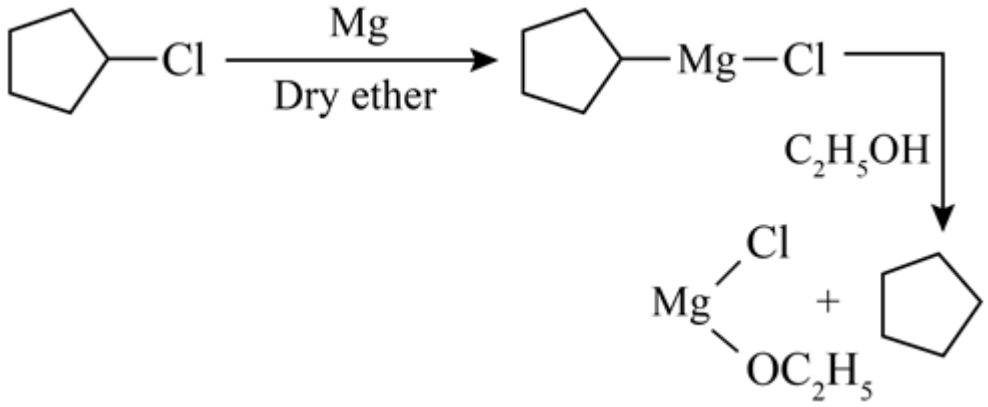


(d)



Answer: (b)

Solution:



Question: Low melting point metals are purified by:

Options:

(a) Liquation

(b) Zone refining

(c) Chromatography

(d) Distillation

Answer: (a)

Solution: Low melting metals are purified by liquidation method in which molten crude metal is allowed to flow on slop with obstacles. Pure metal reaches down into the collector.

Question: V_2O_3 and CrO are respectively:

Options:

(a) Acidic and basic

(b) Basic and amphoteric

(c) Basic and basic

(d) Amphoteric and basic

Answer: (c)

Solution: CrO is basic because Cr is lowest oxidation number (+2)

V_2O_3 is also basic as +3 is the lowest oxidation state of V as well

Question: When 0.75 molal sucrose have a freezing point of –4°C ($K_f = 1.86$), then the amount of ice separated (in grams)

Options:

(a) 350 g

(b) 100 g

(c) 180 g

(d) 650 g

Answer: (d)

Solution:

$\Delta T_f = K_f \times m \times i$

$0 - (-4) = K_f \times m \times 1$

$4 = 1.86 \times m \times 1$

$$4 = 1.86 \times \frac{n_{solute}}{W_{solvent}(kg)} \times 1$$

$W_{solvent} = 0.349$ kg

$\therefore$ Ice formed $= 1 - 0.349 = 0.651$ kg

Question: Tyndall effect is more effectively pronounced in:

Options:

(a) True solution

(b) Lyophobic colloids

(c) Lyophilic colloids

(d) Suspension

Answer: (b)

Solution: Lyophobic colloids are larger in size compared to solution and lyophilic colloid.

The difference in refractive index between particles of dispersed phase and medium is quite large

Question: Number of water molecules present in gypsum, dead burnt plaster and plaster of paris respectively are:

Options:

(a) 2, 0, 0.5

(b) 0.5, 2, 0

(c) 2, 0.5, 0

(d) 0, 2, 0.5

Answer: (a)

Solution:

Gypsum plaster, gypsum powder, or plaster of Paris, is produced by heating gypsum to about 120 – 180 ºC (248 – 356 ºF) in a Klln

$CaSO_4 . 2H_2O + \text{heat} \rightarrow CaSO_4 . \frac{1}{2} H_2O + 1\ \frac{1}{2}\ H_2O$ (released as steam)

Plaster of paris has a remarkable property of setting into a hard mass on wetting with water

$CaSO4 . \frac{1}{2} H_2O + 1\ \frac{1}{2}\ H_2O \rightarrow CaSO_4 . 2H_2O$

Question: The unit of 'a' m

Options:

(a) Atm × L^{-2} mol^2

(b) Atm × L^{-2} mol^{-1}

(c) Atm × L^{-1} mol^2

(d) Atm × L^2 mol^{-2}

Answer: (d)

Solution: Van der waals equation for n moles

$$\left(P + \frac{an^2}{V^2}\right)(V - nb) = nRT$$

So, dimension of P = dimension of $\frac{an^2}{V^2}$

$\frac{an^2}{V^2}$ = atm

a = atm × V^2 × n^{-2}

= Atm × L^2 mol^{-2}

Question: A: ethyl phenyl ether can be prepared by Williamson synthesis

R: bromo benzene on reaction with sodium ethoxide gives ethyl phenyl ether

Options:

(a) A and R are correct and R is the correct explanation of A

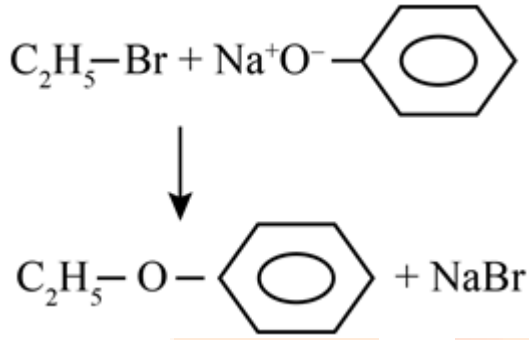
(b) A and R are correct and R is not the correct explanation of A

(c) Both A and R are incorrect

(d) A is correct, R is incorrect

Answer: (d)

Solution: In Williamson synthesis, the alkyl halide should be aliphatic property 1°. So to prepare ethyl phenyl ether we use



If we use bromo benzene, reaction will not take place due to double bond character in C-Br-bond

Question: In carius method 0.2 g of an organic compound gives 0.188 g AgBr. Find % of Br in compound.

Options:

(a) 80 %

(b) 20 %

(c) 40 %

(d) 10 %

Answer: (c)

Solution: AgBr = 188 g/ml

In 188 g AgBr, we have 80 g Br

As per formula $\%\text{of Br} = \frac{80 \times 0.188 \times 100}{188 \times 0.2} = \frac{80}{2} = 40\%$

Question: Match the column.

Column I	**No of lone pairs**

P) XeO_2F_2	**A)** 0
Q) XeF_4	**B)** 1
R) XeF_2	**C)** 2
S) XeO_3F_2	**D)** 3

Options:

(a) P → B; Q → C; R → D; S → A

(b) P → C; Q → D; R → B; S → A

(c) P → A; Q → C; R → B; S → D

(d) P → D; Q → C; R → A; S → B

Answer: (a)

Solution:

XeO_2F_2 ⇒ 1

XeF_4 ⇒ 4

XeF_2 ⇒ 3

XeO_3F_2 ⇒ 0

Question: Match the column.

Column I	**Column II (No of lone pairs)**
P) Fe_3O_4	**A)** Paramagnetic
Q) MnO	**B)** Ferrimagnetic
R) NaCl	**C)** Diamagnetic
S) O_2	**D)** Antiferromagnetic

Options:

(a) Q → A; R → B; S → D; P → C

(b) Q → D; R → A; S → B; P → C

(c) Q → C; R → D; S → A; P → B

(d) Q → D; R → C; S → A; P → B

Answer: (d)

Solution:
MnO ⇒ Antiferromagnetic
NaCl ⇒ Diamagnetic

O_2 ⇒ Paramagnetic

Fe_3O_4 ⇒ Ferrimagnetic

Question: Deuterium is different from hydrogen in which property

Options:

(a) It reacts more vigorously than hydrogen

(b) It reacts less vigorously than hydrogen

(c) It emits beta -particles

(d) Its reactivity is same as that of hydrogen

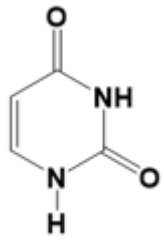
Answer: (b)

Solution: Deuterium reacts less vigorously than hydrogen

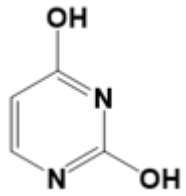
Question: In which form uracil is present in DNA?

Options:

(a)



(b)



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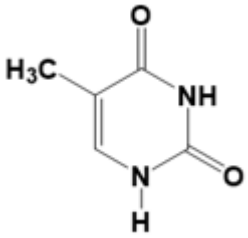
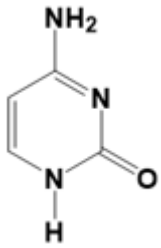
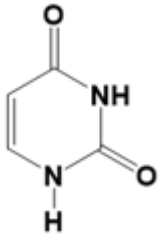


(d)



Answer: (a)

Solution:



Question: When $FeCl_3$ reacts with $K_4[Fe(CN)_6]$, a blue coloured colloidal solution is obtained which is of?

Options:

(a) $KFe[Fe(CN)_6]$

(b) $Fe_4[Fe(CN)_6]_3$

(c) $Fe_4[Fe(CN)_6]_2$

(d) $Fe_3[Fe(CN)_6]_2$

Answer: (b)

Solution:

$$FeCl_3 + K_4[Fe(CN)_6] \rightarrow \underset{\text{(Blue colour)}}{Fe_4[(Fe(CN)_3]_3}$$

Question: Which of the following statements is incorrect about primary amines?

Options:

(a) Primary amines are less basic than secondary amines

(b) Primary amines can be prepared by Gabriel Phthalimide synthesis

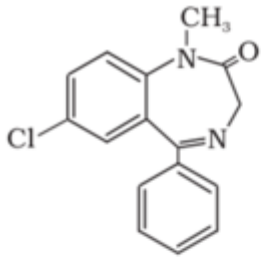
(c) Intermolecular association is more in primary amines than in secondary amines

(d) Primary amines on reaction with nitrous acid give respective alcohol except methyl amine

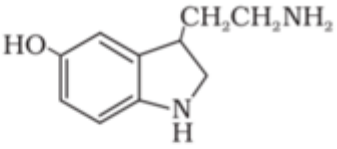
Answer: (d)

Solution: methyl amine also form methanol on reaction with nitrous acid.

Question:

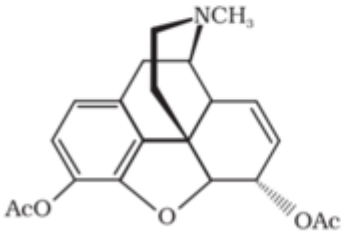


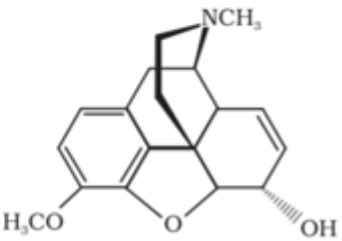
Valium



Serotonin

(A) (B)





(C) (D)

Options:

(a) A, B and C are Narcotic analgesics.

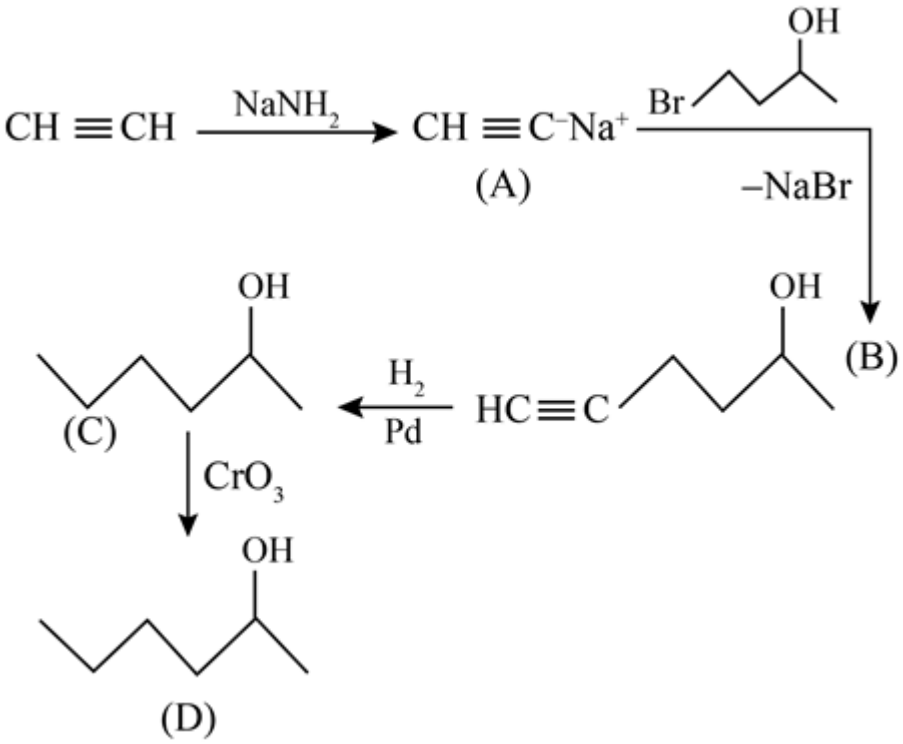
(b) B, C and D are tranquilizers.

(c) B and D are tranquilizers.

(d) C and D are Narcotic analgesics

Answer: (d)

Solution:



Question: 10 ml of $KMnO_4$ reacts with equal volume of 0.1 M Ferrous sulphate in acidic medium. Find strength of $KMnO_4$ in g/lit (nearest integer)

Answer: 3.00

Solution:

$N_1V_1 = N_2V_2$

$n_f = 5$ $(KMnO_4)$ $(FeSO_4)$ $n_f = 1$

$M_1 \times 10 \times 5 = 0.1 \times 10$

$M_1 = \frac{1}{50} = 0.02$ M

Molar mass of $KMnO_4$ = 158 g/mol

Strength = 0.02×158 g/lit

= 3.16 g/lit

Question: One mole of octahedral complex ML_2Cl_3 reacts with $AgNO_3$ to give one mole of AgCl. The denticity of L is

Answer: 2.00

Solution:

Octahedral complex = 6 lone pairs donated

∵ One more complex has one Cl^- ion outside

The coordination sphere

$ML_2Cl_3 \Rightarrow [ML_2Cl_2]Cl$

This shows density of L = 2 (two)

Question: Find the electrons in f orbital in element Np (atomic number 93)

Answer: 4.00

Solution: Np(Neptunium) Z = 93

E configuration = [Rn] $7s^2 6d^1 5f^4$

$5f^4 \Rightarrow$ Answer = 4

JEE-Main-27-08-2021-Shift-1 (Memory Based)

MATHEMATICS

Question: $I=\int_{6}^{16}\frac{\ln x^2}{\ln x^2+\ln\left(x-22\right)^2}dx=?$

Answer: 5

Solution:

$$I=\int_{6}^{16}\frac{\ln x^2}{\ln x^2+\ln\left(x-22\right)^2}dx \qquad ....(1)$$

$$\int_{a}^{b}f\left(x\right)dx=\int_{a}^{b}f\left(a+b-x\right)dx$$

$$I=\int_{6}^{16}\frac{\ln\left(22-x\right)^2}{\ln\left(22-x\right)^2+\ln x^2}dx \qquad ...(2)$$

(1) + (2)

$$2I=\int_{6}^{16}dx\Rightarrow I=5$$

Question: If $\int\frac{dx}{\left(x^2+x+1\right)^2}=A\tan^{-1}\frac{2x+1}{\sqrt{3}}+B\frac{\left(2x+1\right)}{x^2+x+1}$, then find A & B.

Answer: $A=\frac{4}{3\sqrt{3}},B=\frac{1}{3}$

Solution:

$$\int\frac{dx}{\left(1+x+x^2\right)^2}=A\tan^{-1}\left(\frac{2x+1}{\sqrt{3}}\right)+B\left(\frac{2x+1}{1+x+x^2}\right)$$

On differentiating

$$\frac{d}{dx}\left[\tan^{-1}\left(\frac{2x+1}{\sqrt{3}}\right)\right]=\frac{1}{1+\left(\frac{2x+1}{\sqrt{3}}\right)^2}\times\frac{2}{\sqrt{3}}$$

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

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

$$=\frac{-2x^2-2x+1}{\left(1+x+x^2\right)^2}$$

$$\Rightarrow \frac{1}{\left(1+x+x^2\right)^2}=\frac{A\sqrt{3}}{2\left(1+x+x^2\right)}+-2B\left(\frac{1}{1+x+x^2}\right)+\frac{3B}{\left(1+x+x^2\right)^2}$$

$$\Rightarrow 1=\left(1+x+x^2\right)\left(\frac{\sqrt{3}A}{2}-2B\right)+3B$$

$$\Rightarrow \frac{\sqrt{3}A}{2}=2B \text{ and } \frac{\sqrt{3}A}{2}+B=1$$

$$\Rightarrow B=\frac{1}{3}, A=\frac{A}{3\sqrt{3}}$$

Question: If $\frac{z+i}{z+2i}$ is purely real then find locus of z

Answer: y-axis

Solution:

$\frac{z+i}{z+xi}$ is purely real

Let $z=x+iy$

$$\frac{x\_iy+i}{x+iy+2i}=\left(\frac{x+i\left(y+1\right)}{x+i\left(y+2\right)}\right)\left(\frac{x-i\left(y+2\right)}{x-i\left(y+2\right)}\right)$$

Imaginary part $=\frac{-x\left(y+2\right)+x\left(y+2\right)}{x^2+\left(y+2\right)^2}=0$

$$\Rightarrow -xy-2x+xy+x=0$$

$$\Rightarrow x=0$$

Question: $\sum_{k=0}^{20}\left({}^{20}C_k\right)^2=?$

Answer: ${}^{40}C_{20}$

Solution:

$$\sum_{k=0}^{20}\left({}^{20}C_k\right)^2$$

$$=\left({}^{20}C_0\right)^2+\left({}^{20}C_1\right)^2+....+\left({}^{20}C_{20}\right)^2$$

$$={}^{20}C_0\cdot{}^{20}C_{20}+{}^{20}C_1\cdot{}^{20}C_{19}+...+{}^{20}C_{20}\cdot{}^{20}C_2$$

= Coefficient of x^{20} in $(1+x)^{40}$

$$={}^{40}C_{20}$$

Question: A(0, 6) & B(2t,0), where t is parameter midpoint of A & B is M. Perpendicular bisector of AB cuts y-axis at C. Find locus of midpoint of MC

Answer: $3y=9-2x^2$

Solution:

A(0, 6), B(2t, 0)

$$m=(t,3)$$

$$m_{AB}=\frac{6-0}{0-2t}=\frac{-3}{t}$$

Slope of perpendicular bisector $=\frac{t}{3}$

Equation of perpendicular bisector $y-3=\frac{t}{3}(x-t)$

x coordinate of c is 0

$$\Rightarrow y-3=\frac{c}{3}(0,t)$$

$$\Rightarrow y=\frac{-t^2}{3}+3$$

$$\Rightarrow C\equiv\left(0,3-\frac{t^2}{3}\right)$$

Mid point of MC is $\left(\frac{0+t}{2},\frac{3-\frac{t^2}{3}+3}{2}\right)$

$$\Rightarrow \left(\frac{t}{2}, 3-\frac{t^2}{6}\right) \equiv (h,k)$$

$$h=\frac{t}{2}, k=3-\frac{t^2}{6}$$

$$\Rightarrow t=2h$$

$$\Rightarrow k=3-\frac{(2h)^2}{6}$$

$$\Rightarrow y=3-\frac{2x^2}{3}$$

Question: A dice has probability of occurrence of a number $\left(\frac{1}{6}+x\right)$ and the number opposite to it on the dice is $\left(\frac{1}{6}-x\right)$ and the rest of the numbers has probability $\frac{1}{6}$. The probability that when the dice is rolled twice and the sum = 7 is $\frac{13}{96}$. Find x?

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

Solution:

Required probability is

$$\left[\left(\frac{1}{6}-x\right)\left(\frac{1}{6}+x\right)+\left(\frac{1}{6}\right)\left(\frac{1}{6}\right)+\left(\frac{1}{6}\right)\left(\frac{1}{6}\right)\right]\times 2=\frac{13}{96}$$

$$\frac{1}{6}-2x^2=\frac{13}{96}$$

$$2x^2=\frac{3}{96}$$

$$\Rightarrow x=\frac{1}{8}$$

Question: If $u(n)=\prod_{r=0}^{n}\left(1+\frac{r^2}{n^2}\right)^r$ then $\lim_{n\to\infty}(u)^{\frac{-4}{n^2}}$

Answer: $\frac{e^2}{16}$

Solution:

$$y=\lim_{n\to\infty}\prod_{r=0}^{n}\left(1+\frac{r^2}{n^2}\right)^{\frac{-4r}{n^2}}$$

$$\log y=\lim_{n\to\infty}\frac{-4}{n}\left(\frac{r}{n}\right)\sum_{r=0}^{n}\log\left(1+\frac{r^2}{n^2}\right)$$

$$\Rightarrow \log y=-4\int_0^1 x\log\left(1+x^2\right)dx$$

$$\log y=-2\int_1^2 \log t\,dt$$

$$=-2\left[t\log t-t\right]_1^2$$

$$=-2\left[\left(\log 4-2\right)-\left(-1\right)\right]$$

$$=2-\log 16=2-4\log 2$$

$$\log y=\log\frac{e^2}{16}$$

$$\Rightarrow y=\frac{e^2}{16}$$

Question: P(2, -4) is a point on $y^2=8x$. Tangent & normal at P cuts directrix at A & B respectively. If ABPQ is a square then find sum of coordinates of Q.

Answer: 6

Solution:

$y^2=8x$

$P\left(2,-4\right)$

Tangent at $P\equiv -4y=\frac{8\left(x+2\right)}{2}$

$$\Rightarrow -y=x+2$$

$$\Rightarrow y=-x-2$$

$m_T=-1$

$m_N=1$

Equation of normal = $y-\left(-4\right)=1\left(x-2\right)$

$\Rightarrow y+4=x-2$

$\Rightarrow y=x-6$

Directrix is $x=-2$

$\therefore A\equiv(-2,0), B\equiv(-2,-8)$

$P\equiv(2,-4), Q(\alpha,\beta)$

Mid point of AP and BQ will be same

$\Rightarrow \frac{-2+2}{2}=\frac{-2+\alpha}{2}$ and $\frac{0-4}{2}=\frac{-8+\beta}{2}$

$\Rightarrow \alpha=2$ and $\beta=4$

$\alpha+\beta=2+4=6$

Question: If α & β are roots of $x^2+bx+c=0$. Find $\lim\limits_{x\to\beta}\frac{e^{2\left(x^2+bx+c\right)}-1-2\left(x^2+bx+c\right)}{(x-\beta)^2}$

Answer: $2\left(b^2-4c\right)$

Solution:

$$\lim_{x\to\beta}\frac{e^{2(x-\alpha)(x-\beta)}-1-2(x-\alpha)(x-\beta)}{(x-\beta)^2}$$

$$=\lim_{x\to\beta}\frac{e^{2(x-\alpha)(x-\beta)}\cdot 2\cdot\left(2x-(\alpha+\beta)\right)-\left(2x-(\alpha+\beta)\right)}{2(x-\beta)}$$

$$=\lim_{x\to\beta}2\left(2x-(\alpha+\beta)\right)\frac{\left(e^{2(x-\alpha)(x-\alpha)}-1\right)(x-\alpha)}{2(x-\alpha)(x-\beta)}$$

$$=\lim_{x\to\beta}2\left(2x-\alpha+\beta\right)\times 1(x-\alpha)$$

$$=2(\beta-\alpha)^2$$

$$=2\left(\frac{\sqrt{b^2-4c}}{1}\right)^2=2\left(b^2-4c\right)$$

Question: $\left(\sin^{-1}x\right)^2-\left(\cos^{-1}x\right)^2=a$ for $0<x<1$ find $2x^2-1$

Options:

(a) $\sin\left(\frac{2a}{\pi}\right)$

(b) $\cos\left(\frac{4a}{\pi}\right)$

(c) $\cos\left(\frac{2a}{\pi}\right)$

(d) $\sin\left(\frac{4a}{\pi}\right)$

Answer: (a)

Solution:

$\left(\sin^{-1}x\right)^2=\left(\cos^{-1}x\right)^2=a$

Let $\cos^{-1}x=t\Rightarrow x=\cos t$

$\left(\frac{x}{2}-t\right)^2=t^2=a$

$\Rightarrow\frac{\pi^2}{4}+t^2-\pi t-t^2=a$

$\Rightarrow\frac{\pi^2}{4}-\pi t=a$

$\Rightarrow\pi t=\frac{\pi^2}{4}-a$

$\Rightarrow t=\frac{\pi}{4}-\frac{a}{\pi}$

$2x^2-1=2\cos^2 t-1=\cos 2t$

$=\cos 2\left(\frac{\pi}{4}-\frac{9}{\pi}\right)$

$=\cos\left(\frac{\pi}{2}-\frac{29}{\pi}\right)$

$=\sin\frac{29}{\pi}$

Question: $\frac{\sin A}{\sin B}=\frac{\sin(A-C)}{\sin(C-B)}$

Options:

(a) $b^2,c^2,a^2\rightarrow$ A.P.

(b) $a^2, b^2, c^2 \rightarrow$ A.P.

(c)

(d)

Answer: (a)

Solution:

$$\frac{\sin A}{\sin B} = \frac{\sin(A-C)}{\sin(C-B)}$$

$$\sin(C+B)\sin(C-B) = \sin(A+C)\sin(A-C)$$

$$\sin^2 C - \sin^2 B = \sin^2 A - \sin^2 C$$

$$2\sin^2 C = \sin^2 A + \sin^2 B$$

$$\Rightarrow b^2, c^2, a^2 \rightarrow \text{A.P.}$$

Question: An odd natural number n is such that variance of 1, 2, …., n is 14. Find n.

Answer: 13

Solution:

$$\text{Variance} = \frac{\sum x^2}{n} - \frac{\left(\sum x\right)^2}{n^2}$$

$$14 = \frac{1^2 + 2^2 + \ldots + n^2}{n} - \frac{\left(1+2+3+\ldots+n\right)^2}{n^2}$$

$$\Rightarrow 14 = \frac{n(n+1)(2n+1)}{6n} - \left(\frac{n(n+1)}{2n}\right)^2$$

$$\Rightarrow 14 = \frac{(n+1)(2n+1)}{6} - \frac{(n+1)^2}{4}$$

$$\Rightarrow 28 = \frac{2n^2+3n+1}{3} - \frac{n^2+2n+1}{2}$$

$$\Rightarrow 28 = \frac{4n^2+6n+2-3n^2-6n-3}{6}$$

$$\Rightarrow 28 = \frac{n^2-1}{6}$$

$$\Rightarrow n^2 - 1 = 168$$

$$\Rightarrow n^2 = 169$$

$$\Rightarrow n = 13$$

Question: Total length of wire = 20 cm. It is cut into two pieces one is square and other is regular hexagon. Find the side of hexagon such that combined area of square and hexagon is maximum.

Options:

(a)

(b)

(c)

(d)

Answer: ()

Solution:

Let side of square be x & that of hexagon be y

$\therefore 4x+6y=20$

$f(y)=x^2+6\times\frac{\sqrt{3}}{4}\times y^2$

$=\frac{3\sqrt{3}}{2}y^2+\left(\frac{10-3y}{2}\right)^2$

$f'(y)=0\Rightarrow 3\sqrt{3}y-3(10-3y)=0$

$y=\frac{30}{3\sqrt{3}+9}=\frac{10}{3+\sqrt{3}}$

$=\frac{10\left(3-\sqrt{3}\right)}{6}=\frac{5}{3}\left(3-\sqrt{3}\right)$

Question: $\frac{x^2}{b^2}+\frac{y^2}{4a^2}=1$. Find the minimum area of triangle formed by tangent to it.

Answer: $2ab$

Solution:

$\frac{x^2}{b^2}+\frac{y^2}{4a^2}=1$

Tangent at $(b\cos\theta,2a\sin\theta)$ is $\frac{b\cos\theta x}{b^2}+\frac{2a\sin\theta y}{4a^2}=1$

$\frac{\cos\theta x}{b}+\frac{\sin\theta y}{2a}=1$

x-intercept $=\frac{b}{\cos\theta}$

y-intercept $=\frac{2a}{\sin\theta}$

Area $= \frac{1}{2}\frac{b}{\cos\theta}\cdot\frac{2a}{\sin\theta} = \frac{2ab}{\sin 2\theta}$

Minimum area = 2ab when $\sin 2\theta = 1$

Question: $A = \begin{bmatrix} 0 & 2 \\ x & -1 \end{bmatrix}$. $A\left(A^3 + 3I\right) = 25$. Find x .

Answer:

Solution:

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

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

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

$$A^4 = \left(A^2\right)^2 = \begin{bmatrix} 2x & -2 \\ -x & 2x+1 \end{bmatrix}\begin{bmatrix} 2x & -2 \\ -x & 2x+1 \end{bmatrix}$$

$$= \begin{bmatrix} 4x^2+2x & -8x-2 \\ -4x^2-x & 2x+\left(2x+1\right)^2 \end{bmatrix}$$

$$= \begin{bmatrix} 4x^2+2x & -8x-2 \\ -4x^2-x & 4x^2+6x+1 \end{bmatrix}$$

$$A^4 + 3A = \begin{bmatrix} 4x^2+2x & -8x+4 \\ -4x^2+2x & 4x^2+6x-2 \end{bmatrix} = 2I$$

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

Question: $\frac{dy}{dx} + \frac{y}{x} = x^2$ passes through (-2, 2)

Options:

(a)

(b)

(c)

(d)

Answer: ()

Solution:

$$\frac{dy}{dx} + \frac{y}{x} = x^2$$

I.F= $e^{\int \frac{dx}{x}} = x$

$\therefore yx = \frac{x^4}{4} + C$

Passes through (-2, 2)

$c = -4 - 4 = -8$

$\therefore 4xy = x^4 - 32$

Question: Number of distinct real roots of equation $3x^4 + 4x^3 - 12x^2 + 4 = 0$

Options:

(a)

(b)

(c)

(d)

Answer: ()

Solution:

$3x^4 + 4x^3 - 12x^2 + 4 = f(x)$

$f'(x) = 12x^3 + 12x^2 - 24x$

$= 12x(x-1)(x+2)$

$f'(x) = 0 \Rightarrow x = -2, 0, 1$

$f(0) = 4 > 0$

$f(-2) = -28 < 0$

$f(1) = -1 < 0$

$\therefore f(x)$ has 4 distinct real roots

Question: $y = \log_{10} x + \log_{10} x^{\frac{1}{3}} + \log_{10} x^{\frac{1}{a}} + ... \frac{2+4+6+...2y}{3+6+9+...3y} = \frac{4}{\log_{10} x}$. Find (x, y).

Answer: ()

Solution:

$y = \log_{10} x \left[1 + \frac{1}{3} + \frac{1}{9} + ...\right]$

$$S = 1 + \frac{1}{3} + \frac{1}{9} + \ldots = \frac{1}{1 - \frac{1}{3}} = \frac{3}{2}$$

$$y = \frac{3}{2}\log_{10} x \quad \ldots.(1)$$

Also, $\frac{2}{3} = \frac{4}{\log_{10} x} \Rightarrow \log_{10} x = 6$

$x = 10^6, y = 9$