JEE-Main-25-07-2021-Shift-2 (Memory Based)

PHYSICS

Question: A balloon is rising up with constant velocity of 10 m/s. At a height of 75m, a small stone is dropped from it. At what height from the ground would the balloon be, when the mass reaches the ground?

Answer: 125 m

Solution: Let the stone take time t in reaching the ground

Initial velocity of stone $u = +10\,\text{m/s}$

Acceleration $= -g = -10\,\text{m/s}^2$

Height h = -75 m

$$-75 = 10t - \frac{1}{2} \times 10 \times t^2$$
$$\Rightarrow -15 = 2t - t^2$$
$$\Rightarrow t^2 - 5t + 3t - 15 = 0$$
$$\Rightarrow t = 5\,\text{sec}$$

In this time balloon will move up by $10 \times 5 = 50\,\text{m}$

Height of balloon from ground $75 + 50 = 125\,\text{m}$

Question: For the force equation $F = A\cos(Bx) + C\sin(Dt)$. Find dimensions of $\frac{AD}{B}$?

Options:

(a) M^1T^{-1}

(b) $M^1L^2T^{-3}$

(c) M^1T^3

(d) M^1T^{-3}

Answer: (b)

Solution: $F = A\cos(Bx) + C\sin(Dt)$

Bx and Dt will be dimensionless

So, $[B] = \frac{1}{[x]} = \left[M^0L^{-1}T^0\right]$ and $[D] = \frac{1}{[t]} = \left[M^0L^0T^{-1}\right]$

As cos and sin function is dimensionless, so A and C will have dimensions of force

$$[A]=[C]=\left[MLT^{-2}\right]$$

$$\left[\frac{AD}{B}\right]=\frac{\left[MLT^{-2}\right]\left[M^0L^0T^{-1}\right]}{\left[M^0L^{-1}T^0\right]}$$

$$=\left[ML^2T^{-3}\right]$$

Question: A particle starts from rest with acceleration $a=\alpha t+\beta t^2$ where α and β are constant. Find its displacement between t = 1 and t = 2 seconds.

Options:

(a) $\frac{7\alpha}{3}+\frac{5\beta}{4}$

(b) $\frac{7\alpha}{6}+\frac{5\beta}{4}$

(c) $7\alpha+5\beta$

(d) None

Answer: (b)

Solution:

Given, $a=\alpha t+\beta t^2$

$$\Rightarrow \frac{dv}{dt}=\alpha t+\beta t^2$$

$$\Rightarrow \int dv=\int \alpha t\,dt+\int \beta t^2\,dt$$

$$\Rightarrow v=\frac{\alpha t^2}{2}+\frac{\beta t^3}{3}+c$$

At $t=0, v=0$

$$\Rightarrow 0=0+0+c$$

$$\Rightarrow c=0$$

$$v=\frac{dx}{dt}=\frac{\alpha t^2}{2}+\frac{\beta t^3}{3}$$

$$\int_{x_1}^{x_2} dx=\int_1^2 \frac{\alpha t^2}{2}dt+\int_1^2 \frac{\beta t^3}{3}dt$$

$$x_2-x_1=\left[\frac{\alpha t^3}{6}\right]_1^2+\left[\frac{\beta t^4}{12}\right]_1^2$$

$$\Delta x=\frac{8\alpha}{6}-\frac{\alpha}{6}+\frac{16\beta}{12}-\frac{\beta}{12}$$

$$\Delta x = \frac{7\alpha}{6} + \frac{15\beta}{12}$$

$$\Delta x = \frac{7\alpha}{6} + \frac{5\beta}{4}$$

Question: If velocity of photon is C and that of electron is v, then find the ratio of KE of electron to photon if their de-Broglie wavelength is same.

Options:

(a) $\frac{C}{v}$

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

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

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

Answer: (c)

Solution: Given, $\lambda_{Ph} = \lambda_e$

$$\lambda_e = \frac{h}{mv} \ldots (\text{i})$$

Kinetic energy of photon $= \frac{hC}{\lambda_{Ph}} = \frac{hC}{\lambda_e} \ldots (\text{ii})$

Kinetic energy of electron $= \frac{(mv)^2}{2m} = \frac{h^2}{\lambda_e^2 (2m)} \ldots (\text{iii})$

$$\frac{(K.E.)_{Ph}}{(K.E.)_e} = \frac{hC}{\lambda_e} \times \frac{\lambda_e^2 (2m)}{h^2}$$

$$= \frac{\lambda_e (2m) C}{h}$$

From eq. (i)

$$= \frac{2mC}{mv} = \frac{2C}{v}$$

$$\Rightarrow \frac{(K.E.)_E}{(K.E.)_{Ph}} = \frac{v}{2C}$$

Question: Two soap bubbles of radius R_1 and R_2 combine isothermally to form a new soap bubble. Find the radius of the new soap bubble formed

Options:

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

(b) $\sqrt{R_1 R_2}$

(c) $\frac{R_1 R_2}{R_1 + R_2}$

(d) $\sqrt{R_1^2 + R_2^2}$

Answer: (d)

Solution: Radius of first soap bubble is R_1

Radius of first soap bubble is R_2

Let, $P_1 = \frac{4T}{R_1}, V_1 = \frac{4}{3}\pi R_1^3$, be the excess pressure inside first soap bubble and volume of first soap bubble respectively.

$P_2 = \frac{4T}{R_2}, V_2 = \frac{4}{3}\pi R_2^3$ be the excess pressure inside second soap bubble and volume of second soap bubble respectively.

$P = \frac{4T}{R}, V = \frac{4}{3}\pi R^3$ be the excess pressure inside new soap bubble, volume and radius of new soap bubble respectively.

The two bubbles combine isothermally, hence

$$PV = P_1 V_1 + P_2 V_2$$

$$\frac{4T}{R}\left(\frac{4}{3}\pi R^3\right) = \frac{4T}{R_1}\left(\frac{4}{3}\pi R_1^3\right) + \frac{4T}{R_2}\left(\frac{4}{3}\pi R_2^3\right)$$

$$R^2 = R_1^2 + R_2^2$$

$$R = \sqrt{R_1^2 + R_2^2}$$

Question: Two dipoles p_1 and p_2 are perpendicular to each other, are placed in a uniform magnetic filed such that p_1 makes an angle of $37°$ with field. Both dipoles experiences same torque. Find ratio of their dipole moment.

Options:

(a) $\frac{4}{3}$

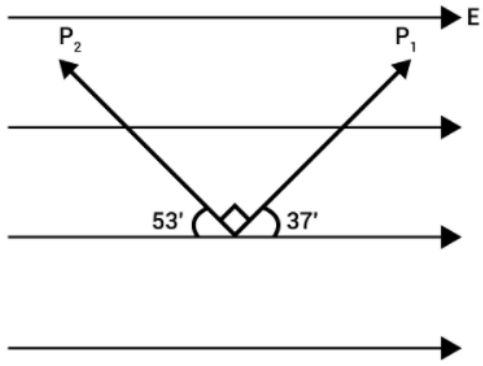
(b) $\frac{3}{4}$

(c) $\frac{3}{5}$

(d) $\frac{4}{5}$

Answer: (a)

Solution:



Torque $= \vec{P} \times \vec{E} = PE \sin\theta$

Torque on dipole one $\tau_1 = P_1 \times E$

$= P_1 E \sin 37°$

$= P_1 E \times \frac{3}{5}$

Similarly $\tau_2 = P_2 \times E$

$= P_2 E \sin(90 + 37°)$

$= P_2 E \cos 37°$

$= P_2 E\left(\frac{4}{5}\right)$

$\tau_1 = \tau_2$

$P_1 E \times \frac{3}{5} = P_2 E \frac{4}{5}$

$\frac{P_1}{P_2} = \frac{4}{3}$

Question: If $\vec{X}$ and $\vec{Y}$ are two vectors, such that $\left|\vec{X}\right| = \left|\vec{Y}\right| \& \left|\vec{X} - \vec{Y}\right| = 10\left|\vec{X} + \vec{Y}\right|$, then. Find the angle between $\vec{X}$ and $\vec{Y}$

Options:

(a) $\cos^{-1}\left(\frac{-7}{99}\right)$

(b) $\cos^{-1}\left(\frac{-99}{101}\right)$

(c) $\sin^{-1}\left(\frac{-99}{101}\right)$

(d) $\sin^{-1}\left(\frac{-7}{99}\right)$

Answer: (b)

Solution: $\left|\vec{X}\right| = \left|\vec{Y}\right| = A$

$$\left|\vec{X} - \vec{Y}\right| = 10\left|\vec{X} + \vec{Y}\right|$$

$$X^2 + Y^2 - 2XY\cos\theta = 100\left(X^2 + Y^2 + 2XY\cos\theta\right)$$

$$A^2 + A^2 - 2A^2\cos\theta = 100\left(A^2 + A^2 + 2A^2\cos\theta\right)$$

$$2A^2 - 2A^2\cos\theta = 200A^2 + 200A^2\cos\theta$$

$$198A^2 = -202A^2\cos\theta$$

$$\cos\theta = \frac{-99}{101}$$

$$\theta = \cos^{-1}\left(\frac{-99}{101}\right)$$

Question: A disc of radius 2 metres and mass M, is rotating with 200 rpm. Find the torque required to step the disc in 10 seconds.

Options:

(a) $\frac{4\pi M}{3}$ SI units

(b) $\frac{2\pi M}{3}$ SI units

(c) $\frac{\pi M}{3}$ SI units

(d) $\frac{8\pi M}{3}$ SI units

Answer: (a)

Solution:

R = 2 m, mass = M

$$w_0 = 200\,\text{rpm} = 200 \times \frac{\pi}{30} = \frac{20\pi}{3}\,\text{rad/sec}$$

$$w = 0$$

$$t = 10\,\text{sec}$$

$$w = w_0 + \alpha t$$

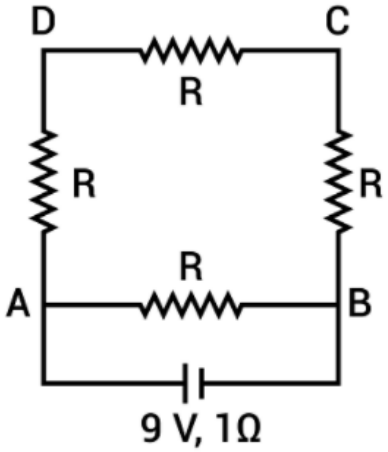
$$0 = \frac{20\pi}{3} + \alpha(10)$$

$$\alpha = \frac{2\pi}{3}$$

$$\text{Torque}(\tau) = I\alpha; I = \frac{MR^2}{2} = 2M$$

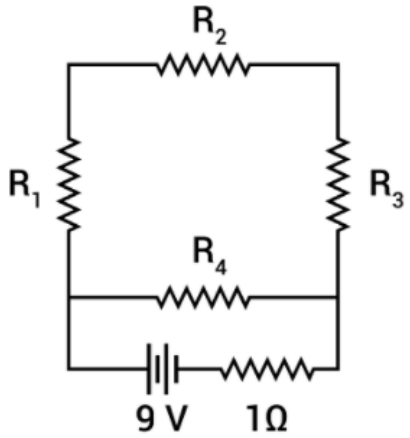
$$= \frac{4\pi M}{3}\,\text{units}$$

Question: A wire of 16 ohms is bent to form a square. Now a cell of 9 volt and internal resistance 1Ω is connected across one of the sides. Find the potential difference across the diagram of the square.



Options:
(a) 8 V
(b) 5.5 V
(c) 6.75 V
(d) 3.5 V
Answer: (c)
Solution:

$$R = 16\Omega$$



$R_1 = R_2 = R_3 = R_4 = 4\Omega$

$R_{eq} = 3\Omega + 1\Omega = 4\Omega$

$R_{eq} = 4\Omega$

Using ohm's law, V = IR

$9 = I \times 4$

$I = \frac{9}{4}\text{A}$

I is the total current flowing across circuit voltage across internal resistance $= IR'$

$= \frac{9}{4} \times 1 = \frac{9}{4}\text{V}$

Voltage across square diagram $= 9 - \frac{9}{4}$

$= 6.75\,\text{V}$

Question: If $\delta_{\min}$ is the minimum deviation through a prism and μ is refractive index and A is angle of prism, then

Options:

(a) $\mu = \dfrac{\sin\left(\delta_{\min}\right)}{\sin\left(\dfrac{A}{2}\right)}$

(b) $\mu = \dfrac{\sin\left(\dfrac{A+\delta_{\min}}{2}\right)}{\sin\left(\dfrac{A}{2}\right)}$

(c) $\mu = \dfrac{\sin\left(\dfrac{A}{2}\right)}{\sin\left(\dfrac{A+\delta_{\min}}{2}\right)}$

(d) None of these

Answer: (b)

Solution:

Formula for refractive index of prism.

$$\mu = \frac{\sin\left(\dfrac{A+\delta_{\min}}{2}\right)}{\sin\left(\dfrac{A}{2}\right)}$$

Question: A radioactive nucleus decays so that after 30 years, only $\frac{1}{8}^{th}$ of the initial sample is active. What is the half life of sample?

Options:

(a) 20 years

(b) 10 years

(c) 40 years

(d) 5 years

Answer: (b)

Solution:

$\frac{1}{8}^{th}$ of the initial samples is active after 30 days.

So, $\frac{1}{8} = \left(\frac{1}{2}\right)^3$

i.e., it required 3 half life for this.

3 half life = 30 days.

So, 1 half life = 10 days

Question: For an amplitude modulated wave, message signal peak voltage = 20 V, carrier signal peak voltage = 20 V. What is the modulation index?

Options:

(a) 50%

(b) 200%

(c) 0%

(d) 100%

Answer: (d)

Solution:

$$\text{Modulation index} = \frac{\text{Peak value of modulating signal}}{\text{Peak value of carrier signal}}$$

$$= \frac{20}{20} = 1$$

$$\% \text{ Modulation} = 1 \times 100 = 100\%$$

Question: Two charges of equal magnitude are thrown with speeds ratio (3 : 2) perpendicular to the magnetic field. If their masses are in the ratio of 1 : 2. Find ratio of the radii?

Options:

(a) $\frac{4}{3}$

(b) $\frac{3}{4}$

(c) $\frac{1}{3}$

(d) 3

Answer: (b)

Solution:

$$R = \frac{mv}{qB} \text{(charges are equal)}$$

$$R_1 = \frac{m_1 v_1}{qB}$$

$$R_2 = \frac{m_2 v_2}{qB}$$

$$\frac{R_1}{R_2} = \frac{m_1}{m_2} \times \frac{v_1}{v_2}$$

$$\frac{R_1}{R_2} = \frac{1}{2} \times \frac{3}{2} \quad \left[\because \frac{m_1}{m_2} = \frac{1}{2} \text{ and } \frac{v_1}{v_2} = \frac{3}{2} \right]$$

$$\frac{R_1}{R_2} = \frac{3}{4}$$

Question: For a certain incident wavelength on a metal surface, the max KE of the photoelectron is 4.8 eV. If the incident wavelength is doubled, then the max KE changes to 1.6 eV. Then find the threshold wavelength for the metal surface.

Options:

(a) 7750 nm

(b) 775 nm

(c) 77.5 nm

(d) can't be determined

Answer: (b)

Solution:

$$KE_{\max} = \frac{hc}{\lambda} - \phi$$

$$KE_{\max 1} = 4.8ev = \frac{hc}{\lambda} - \phi ...(1)$$

$$KE_{\max 2} = 1.6ev = \frac{hc}{2\lambda} - \phi ...(2)$$

Multiply equation (2) by 2

$$1.6 \times 2ev = \frac{hc}{\lambda} - 2\phi ...(3)$$

eq (1) – eq (3) we get

$$1.6ev = \phi$$

So,

$$\phi = \frac{hc}{\lambda_0} = 1.6$$

$$\lambda_0 = \frac{1240}{1.6} nm = 775nm$$

Question: The efficiency of heat engine is $\frac{1}{6}$. When the temperature of sink is reduced by $62°C$, then efficiency doubles. What is the temperature of the source?

Answer: ($T_1 = 372K$)

Solution:

Given,

$$\frac{1}{6} = 1 - \frac{T_{\text{sink}}}{T_{\text{source}}}$$

$$\Rightarrow \frac{T_{\text{sink}}}{T_{\text{source}}} = \frac{5}{6}$$

Also,

$$\frac{2}{6} = 1 - \frac{T_{\text{sink}} - 62}{T_{\text{source}}}$$

$$\Rightarrow \frac{62}{T_{\text{source}}} = \frac{1}{6}$$

$$\therefore T_{\text{source}} = 372K$$

Question: Two particles having identical masses and changes 2Q and Q are moving with velocities V and 2V respectively, In uniform magnetic field B. Find ratio of the radius of circle describe by them

Options:

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

(b) 2 : 1

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

(d) 4 : 1

Answer: (c)

Solution:

$$\frac{mV^2}{R} = qVB$$

$$\Rightarrow R = \frac{mV}{qB}$$

$$\Rightarrow \frac{R_1}{R_2} = \frac{Q}{2Q} \times \frac{V}{2V} = \frac{1}{4}$$

Question: A force $(5y+4)\hat{j}$ displaces a particle from y = 0 to y = 2. Find work done by force.

Options:

(a) 16 J

(b) 18 J

(c) 20 J

(d) 22 J

Answer: (b)

Solution:

$$w \cdot d = \int_0^2 Fy \cdot dy$$

$$= \int_0^2 (5y+4)\,dy$$

$$= \left[\frac{5y^2}{2} + 4y\right]_0^2$$

$$= 18J$$

Question: In an AC circuit having resistance of 10Ω, find the time taken by current to reach RMS value from maximum value. Frequency and RMS voltage of the source is 50 Hz and 220 V respectively.

Options:

(a) 2.5 msec

(b) 5 msec

(c) 10 msec

(d) 1 msec

Answer: (a)

Solution:

$$V_{rms} = \frac{V_{peak}}{\sqrt{2}}$$

$$V = V_{peak} \sin\left(\omega t + \frac{\pi}{2}\right)$$

$$\left[\because \text{at } t = 0 \;\; V = V_{peak}\right]$$

For V_{rms},

$$\Rightarrow \frac{V_{peak}}{\sqrt{2}} = V_{peak} \cos \omega t$$

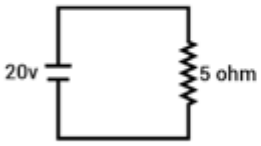
$$\Rightarrow \cos \omega t = \frac{1}{\sqrt{2}}$$

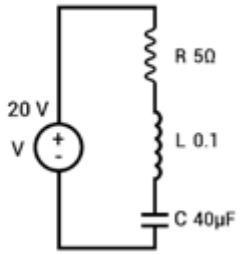
$$\omega t = \frac{\pi}{4}$$

$$\Rightarrow (2\pi f) t = \frac{\pi}{4}$$

$$\Rightarrow t = \frac{1}{8f} = 2.5ms.$$

Question: For both the given circuits, average power dissipated is same. Find ω of the second circuit.





Options:

(a) 1000 rad/sec

(b) 500 rad/sec

(c) 100 rad/sec

(d) 5000 rad/sec

Answer: (b)

Solution:

For left circuit,

$$P = 20 \times \frac{20}{5} = 80w,$$

For right circuit,

$$P = 20 \times \frac{20}{\cancel{Z}} \times \frac{R}{\cancel{Z}}$$

$$\cancel{Z} = \sqrt{R^2 + \left(X_L - X_C\right)^2}$$

Equating

$$80 = \frac{400R}{\not{Z}^2}$$

$$\not{Z}^2 = \frac{400 \times 5}{80}$$

$$\Rightarrow \not{Z} = 5$$

$$R = \not{Z}\left(\text{Resonance}\right)$$

$$\Rightarrow w = \frac{1}{\sqrt{LC}}$$

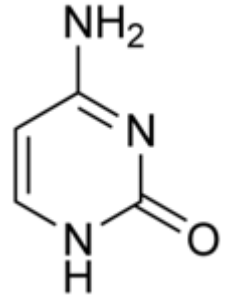
$$= \frac{1}{\sqrt{0.1 \times 40 \times 10^{-6}}}$$

$$= 500 rad / s$$

JEE-Main-25-07-2021-Shift-2 (Memory Based)

CHEMISTRY

Question: What is the correct structure of cytosine
Solution:



Question: Which of the following form interstitial hydride easily?
Options:
(a) Cr
(b) Fe
(c) Mn
(d) Co
Answer: (a)
Solution: These are formed by many d-block and f-block elements. However, the metals of group 7, 8 and 9 do not form hydride. Even from group 6, only chromium forms CrH.

Question: Increasing order of Bond order of : O_2 , O_2^+ , O_2^- , O_2^{2-}
Options:
(a) $O_2^+ > O_2 > O_2^- > O_2^{2-}$
(b) $O_2 > O_2^+ > O_2^- > O_2^{2-}$
(c) $O_2^- > O_2 > O_2^+ > O_2^{2-}$
(d) $O_2^{2-} > O_2 > O_2^+ > O_2^-$
Answer: (a)
Solution:
Bond order

	O_2^+	O_2	O_2^-	O_2^{2-}
No. of electron	15	16	17	18
	2.5	2	1.5	1

Bond order $O_2^+ > O_2 > O_2^- > O_2^{2-}$

Question: If work done by system is 200 J and heat absorbed is 150 then what is change in internal energy?

Options:
(a) +50 J
(b) -50 J
(c) 350 J
(d) -350 J
Answer: (b)
Solution:
W = -200 J
q = + 150 J
$\Delta U = q + w$
$\Delta U = 150 - 200 = -50J$

Question: Number of electrons in 4f orbitals of Ho^{3+} (Z = 67)
Options:
(a) 10
(b) 12
(c) 11
(d) 9
Answer: (a)
Solution:
$HO = 4f^{11} \quad 6s^2$
$HO^{3+} = 4f^{10}$

Question: Match the column

Column I	Column II
(i) Clouds	(P) Gel
(ii) Pumice stone	(Q) Aerosols
(iii) Cheese	(R) Solid foam
(iv) Shaving cream	(S) Emulsion

Options:
(a) (i) → Q, (ii) → R, (iii) → P, (iv) → S
(b) (i) → S, (ii) → R, (iii) → Q, (iv) → P
(c) (i) → P, (ii) → Q, (iii) → S, (iv) → R
(d) (i) → R, (ii) → S, (iii) → P, (iv) → Q
Answer: (a)
Solution:

Column I	Column II
(i) Clouds	(Q) Aerosols
(ii) Pumice stone	(R) Solid foam
(iii) Cheese	(P) Gel
(iv) Shaving cream	(S) Emulsion

Question: S1 : Chlorofluorocarbon react in the visible range and Cl radical is formed
S2: O_3 react with nitric acid to form nitrogen and oxygen
Options:
(a) S1 is true and S2 is false
(b) S1 is false, S2 is true

(c) Both Statements are true
(d) Both statements are false
Answer: (d)
Solution:

S_1 $\quad CFC + UV \rightarrow Cl^{\cdot}$

S_2 $\quad O_3 + NO \rightarrow NO_2 + O_2$

S_1 wrong
S_2 wrong

Question: Biodegradable polyamide is formed by which of these two reactant?
Options:
(a) Glycine, amino caproic acid
(b) Vinyl chloride, glycine
(c) Glucose, adipic acid
(d) Adipic acid, Hexamethylenediamine
Answer: (a)
Solution: Nylon 2-nylon 6
It is an alternating polyamide copolymer of glycine ($H_2N\text{-}CH_2^-$ COOH) and amino caproic acid [H_2N $(CH_2)_5$ COOH] and is biodegradable.

Question: Match the column

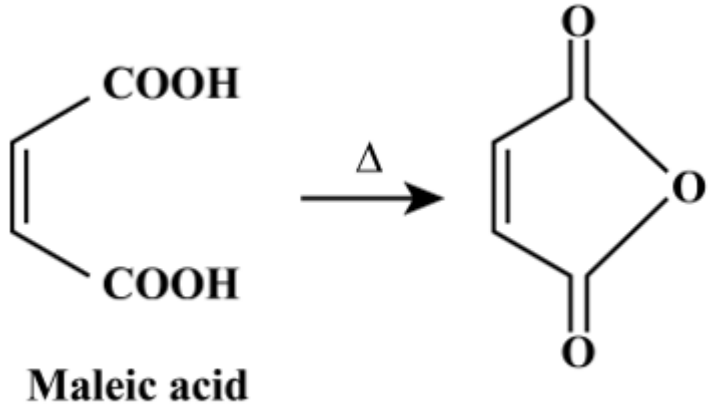
Column I	Column II
(i) Froth floatation method	P. Sulphide ore
(ii) Reverberatory furnace	Q. Pig iron
(iii) Blast furnace	R. Ag
(iv) Leaching	S. Blister Copper

Options:
(a) (i) → Q, (ii) → R, (iii) → P, (iv) → S
(b) (i) → S, (ii) → R, (iii) → Q, (iv) → P
(c) (i) → P, (ii) → S, (iii) → Q, (iv) → R
(d) (i) → R, (ii) → S, (iii) → P, (iv) → Q
Answer: (c)
Solution:

Column I	Column II
(i) Froth floatation method	P. Sulphide ore
(ii) Reverberatory furnace	S. Blister Copper
(iii) Blast furnace	Q. Pig iron
(iv) Leaching	R. Ag

Question: maleic anhydride can be prepared by

Options:
(a) Heating trans but-2-en-1,4-dioic acid
(b) treating trans but-2-en-1, 4-dioic acid with alcohol and acid
(c) treating cis but-2-en-1 4-dioic acid with alcohol and acid
(d) Heating cis but-2-en-1, 4-dioic acid
Answer: (d)
Solution:



Maleic acid

Question: A → B. In this reaction concentration of change B changes by 0.2 in 30 minutes. Find the average rate of the reaction in moles per litre hour
Answer: 0.4
Solution:

$$\text{Rate} = \frac{\Delta C}{\Delta t} = \frac{0.2}{0.5}$$

$$\Delta t = \frac{30}{60} = 0.5$$

$$= 0.4 mol / lit^{-1}, \mathrm{H}\, r^{-1}$$

Question: $[Ba(OH)_2] = 5 \times 10^{-3}$, It dissociates completely , Find the conc of H_3O^+
Options:
(a) $10^{-12} M$
(b) $10^{-10} M$
(c) $10^{-11} M$
(d) $2 \times 10^{-10} M$
Answer: (a)
Solution:

$$\left[OH^-\right] = 2 \times 5 \times 10^{-3}$$

$$\left[OH^-\right] = 10^{-2} M$$

$$\left[H^+\right]\left[OH^-\right] = 10^{-14}$$

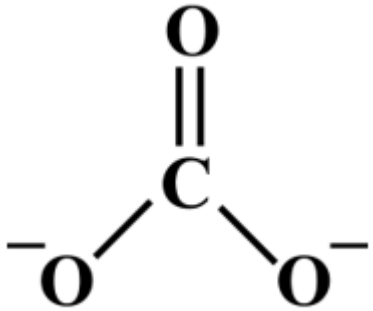
$$\left[H^+\right] = \frac{10^{-14}}{10^{-2}}$$

$$\left[H^+\right] = 10^{-12}$$

Question: Which reaction oxidation state gets changed by +5
Options:
(a) $C_2O_4^{2-}$ to CO_2
(b) MnO_4^- to Mn2+
(c) $Cr_2O_7^{2-}$ to Cr^{3+}
(d) CrO_4^{2-} to Cr^{3+}
Answer: (b)
Solution:
$\underset{+7}{MnO_4^-} \rightarrow \underset{+2}{Mn^{+2}}$
Change by 5

Question: Find magnetic moments for Sc^{3+} , V^{2+} , Ti^{2+}
Options:
(a) 0, 2.8, 1
(b) 1.5, 0, 2.8
(c) 0, 3.9, 2.8
(d) 1, 2.7, 3.9
Answer: (c)
Solution:
$Sc^{3+} \Rightarrow d^{\circ}, \mu = 0\, B.M$
$V^{2+} \Rightarrow d^3, \mu \approx 3.9\, B.M$
$Ti^{2+} \Rightarrow d^2, \mu = 2.8\, B.M$

Question: Maximum canonical form with 1 pi bond
Options:
(a) CO_3^{2-}
(b) SO_3
(c) SO_3
(d) O_2
Answer: (a)
Solution:



Question: In Kjeldahl method, 0.8 g of organic compound is used . % of nitrogen come out to be 46% . the ___ ml of 1 M H_2SO_4 used to neutralize NH_3
Options:

(a) 15.20 mL
(b) 13.14 mL
(c) 12.00 mL
(d) 7.80 mL
Answer: (b)
Solution:

$$\%N = \frac{1.4 \times N \times V}{w}$$

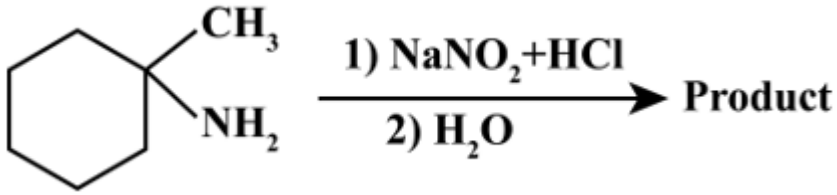
$$46 = \frac{1.4 \times 2 \times V}{0.8}$$

$$V = 13.14\,mL$$

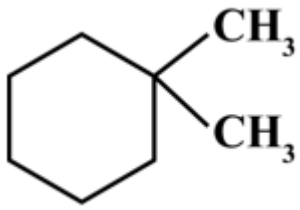
Question: Arrange the following in increasing density order:
Options:
(a) Benzene
(b) Chlorobenzene
(c) 1,3 chlorobenzene
(d) 1-bromo-3-chlorobenzene
Answer: (d)
Solution:
Density ∝ mass
Benzene < chlorobenzene < 1,3 dichlorobenzene < 1 Bromo 3 chlorobenzene

Question: Which compound is most stable?
Options:
(a) $[Co(en)_2(NH_3)_2]Cl_2$
(b) $[Co(en)(NH_3)_4]Cl_2$
(c) $[Co(en)_3]Cl_2$
(d) $[Co(NH_3)_6]Cl_2$
Answer: (c)
Solution:
$\left[Co\left(en\right)_3\right]Cl_2$ chelation
Ligands form more stable complexes.

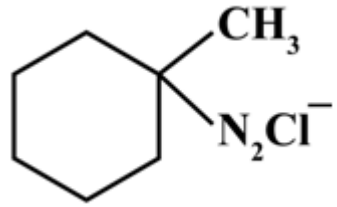
Question:



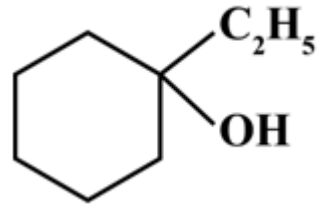
Options:
(a)



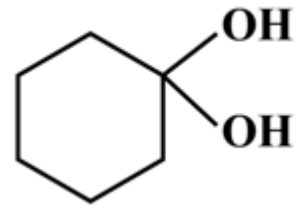
(b)



(c)

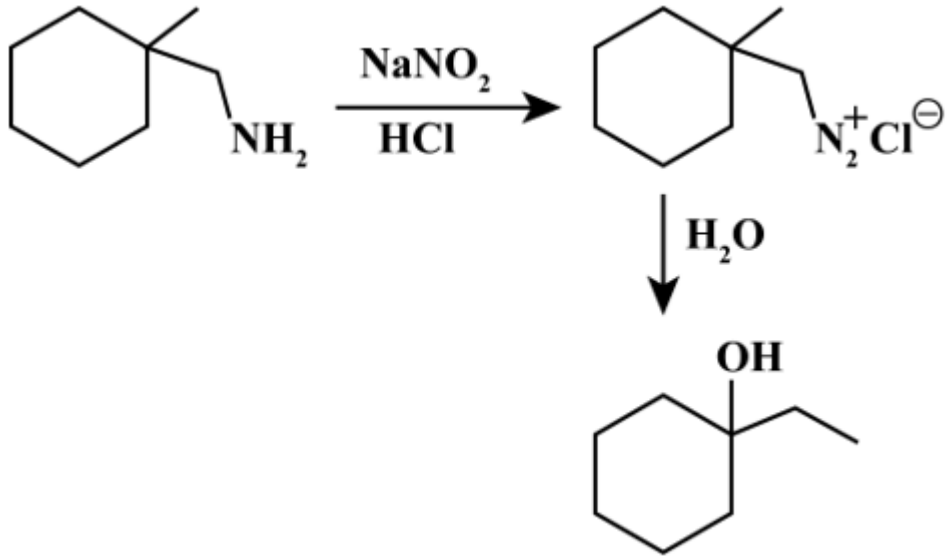


(d)



Answer: (c)

Solution:



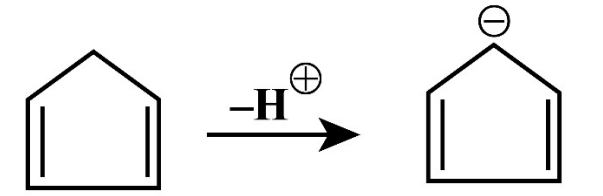
Question: Most acidic amongst these is:

Options:

(a) toluene

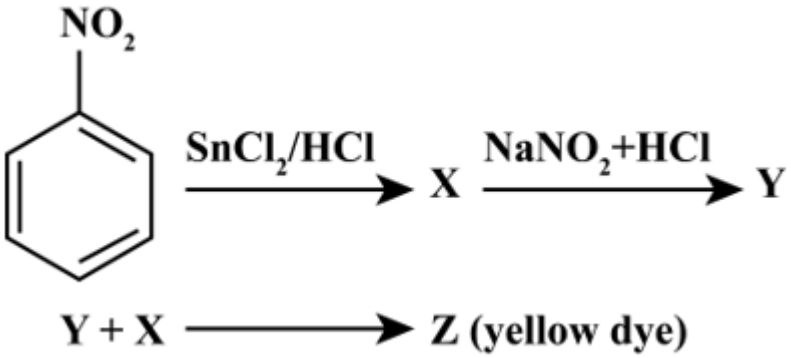
(b) butane

(c) cyclopropene
(d) cyclopentadiene
Answer: (d)
Solution:

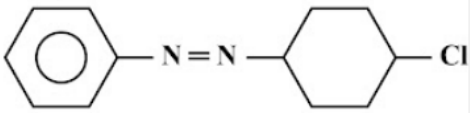


Strongly acidic **Aromatic**

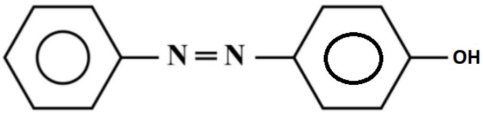
Question: Y + aniline reacts to give yellow dye. Find structure of yellow dye



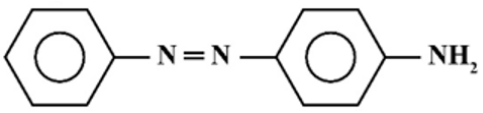
Identify Z
Options:
(a)



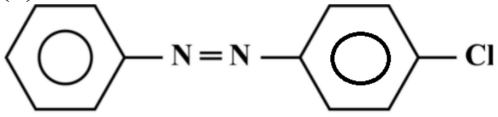
(b)



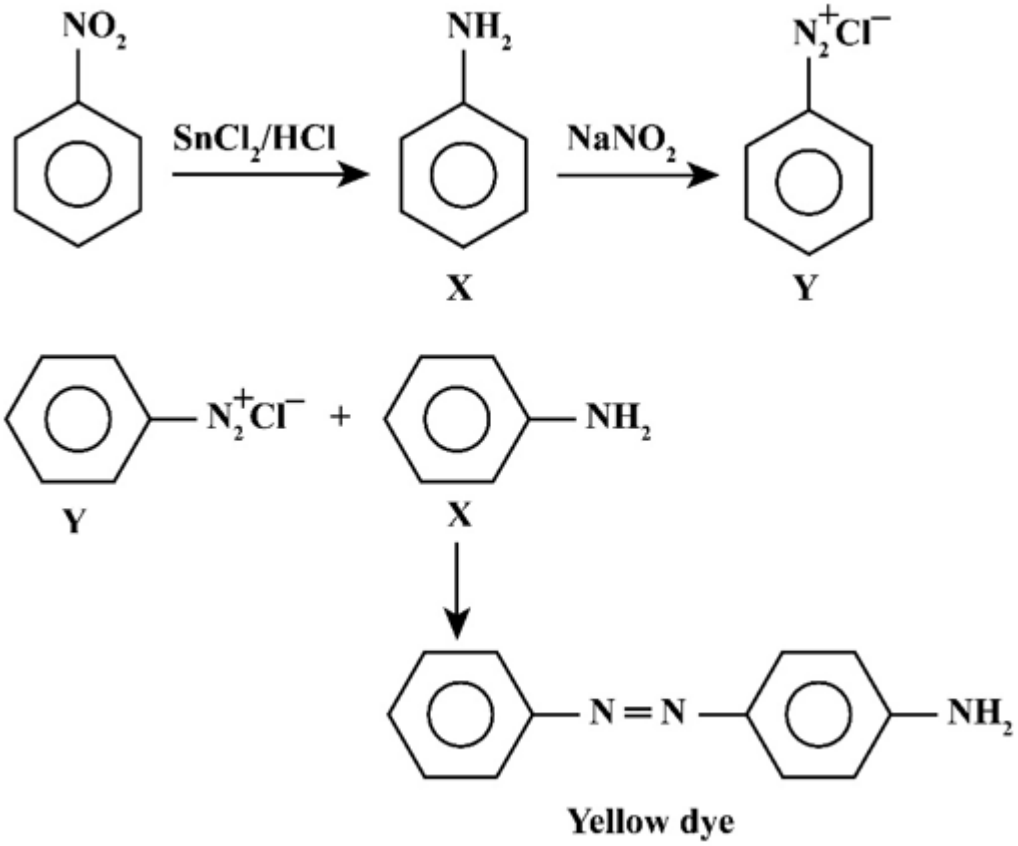
(c)



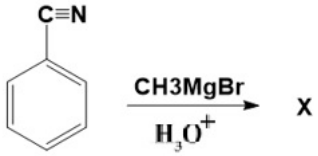
(d)



Answer: (c)
Solution:



Question:



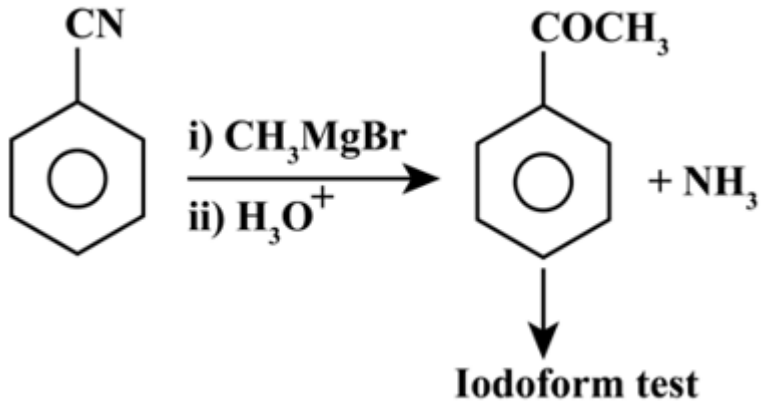
X shows

Options:

(a) Ninhydrin test
(b) Iodoform
(c) Tollen's test
(d) Fehling's test

Answer: (b)

Solution:



Question: Match the column

Column I	Column II
(i) Li	P. Bicarbonate used in Fire extinguisher
(ii) Cs	Q. element in fluid of cell
(iii) Na	R. Carbonate that disintegrate
(iv) K	S. Forma unstable compound with I^-

Options:

(a) (i) → Q, (ii) → R, (iii) → P, (iv) → S
(b) (i) → R, (ii) → S, (iii) → P, (iv) → Q
(c) (i) → P, (ii) → S, (iii) → Q, (iv) → R
(d) (i) → R, (ii) → S, (iii) → P, (iv) → Q

Answer: (b)

Solution:

Column I	Column II
(i) Li	R. Bicarbonate used in Fire extinguisher
(ii) Cs	S. element in fluid of cell
(iii) Na	P. Carbonate that disintegrate
(iv) K	Q. Forma unstable compound with I^-

JEE-Main-25-07-2021-Shift-2 (Memory Based)

MATHEMATICS

Question: Real solution of $x^2-|x|-12=0$

Options:

(a) 1

(b) 2

(c) 3

(d) 4

Answer: (b)

Solution:

$(|x|-4)(|x|+3)=0 \Rightarrow |x|=4 \Rightarrow x=\pm 4$

Number of real solution is 2

Question: If ${}^nP_r={}^nP_{r+1}$, ${}^nC_r={}^nC_{r-1}$. Find r

Options:

(a)

(b) 2

(c)

(d) $r-1$

Answer: (b)

Solution:

$${}^nP_r={}^nP_{r+1} \Rightarrow \frac{n!}{(n-r)!}=\frac{n!}{(n-r-1)!} \Rightarrow n-r=1$$

$${}^nC_r={}^nC_{r-1} \Rightarrow \frac{n!}{r!\cdot(n-r)!}=\frac{n!}{(r-1)!\cdot(n-r+1)!}$$

$$r=n-r+1 \Rightarrow 2r=1+1+r \Rightarrow r=2$$

Question: $y=p(x)$ & $y=q(x)$ are lines can be written as $(y-p_x)(y-q_x)=0$, then find angle bisector of $x^2-4xy-5y^2=0$

Options:

(a) $x^2+3xy-y^2=0$

(b)

(c)

(d)

Answer: (a)

Solution:

Equation of angle bisector is $\frac{x^2-y^2}{xy}=\frac{a-b}{h}$

$$\Rightarrow \frac{x^2-y^2}{xy}=\frac{6}{-2}=-3$$
$$\Rightarrow x^2+3xy-y^2=0$$

Question: If $f(x)=\begin{cases} 5x+1, & x<2 \\ \int_0^n (5+|1-t|)\,dt, & x\geq 2 \end{cases}$

Options:

(a) $f(x)$ is differentiable $\forall\ x\in R$

(b) $f(x)$ is continuous at $x=2$ but not differentiable at $x=2$

(c) $f(x)$ is continuous at $x=2$ but not differentiable at $x=1$

(d)

Answer: (b)

Solution:

$$f(x)=\begin{cases} 5x+1, & x<2 \\ \int_0^n (5+|1-t|)\,dt, & x\geq 2 \end{cases}$$
$$f(2^+)=\int_0^1 (6-t)\,dt+\int_1^x (t+4)\,dt$$
$$f(2^+)=\frac{11}{2}+\left(\frac{t^2}{2}+4t\right)_1^x=\frac{11}{2}+\frac{x^2}{2}+4x-\frac{1}{2}-4$$
$$f(2^+)=\frac{x^2}{2}+4x+1$$
$$f(2^-)=f(2^+)=11 \text{ (continuous)}$$
$$f'(2^-)=5,\ f'(2^+)=6 \text{ (not differentiable)}$$

Question: $\int_{-1}^{1} \log\left(x+\sqrt{x^2+1}\right)dx$

Answer: 0.00

Solution:

$$I=\int_{-1}^{1} \log\left(x+\sqrt{x^2+1}\right)dx=\int_{-1}^{1} \log\left(-x+\sqrt{x^2+1}\right)dx$$
$$2I=\int_{-1}^{1} \log 1\,dx$$
$$\Rightarrow I=0$$

Question: If $P=\begin{bmatrix}1 & 0\\ \frac{1}{2} & 1\end{bmatrix}$ then $P^{50}=?$

Answer:

Solution:

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

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

$$P^3=\begin{bmatrix}1 & 0\\ 1 & 1\end{bmatrix}\begin{bmatrix}1 & 0\\ \frac{1}{2} & 1\end{bmatrix}=\begin{bmatrix}1 & 0\\ \frac{3}{2} & 1\end{bmatrix}$$

$$\therefore P^n=\begin{bmatrix}1 & 0\\ \frac{n}{2} & 1\end{bmatrix}\Rightarrow P^{50}=\begin{bmatrix}1 & 0\\ 25 & 1\end{bmatrix}$$

Question: If $|\vec{a}|=2,\ |\vec{b}|=5,\ |\vec{a}\times\vec{b}|=8$, then $|\vec{a}.\vec{b}|=?$

Answer: 6.00

Solution:

$$|\overline{a}\times\overline{b}|=|\overline{a}||\overline{b}|\sin\theta$$

$$\Rightarrow \sin\theta=\frac{4}{5}\Rightarrow\cos\theta=\frac{3}{5}$$

$$\therefore |\overline{a}\cdot\overline{b}|=|\overline{a}||\overline{b}|\cos\theta=6$$

Question: If $\frac{\pi}{4}\le x\le\frac{\pi}{4}\begin{vmatrix}\sin x & \cos x & \cos x\\ \cos x & \sin x & \cos x\\ \cos x & \cos x & \sin x\end{vmatrix}=0$, number of solutions = ?

Answer: 1.00

Solution:

$$\begin{vmatrix}\sin x & \cos x & \cos x\\ \cos x & \sin x & \cos x\\ \cos x & \cos x & \sin x\end{vmatrix}=0$$

$$R_1\to R_1+R_2+R_3$$

$$(\sin x+2\cos x)\begin{vmatrix}1 & 1 & 1\\ \cos x & \sin x & \cos x\\ \cos x & \cos x & \sin x\end{vmatrix}=0$$

$$C_2\to C_2-C_1;\ C_3\to C_3-C_1$$

$$(\sin x+2\cos x)\begin{vmatrix} 1 & 0 & 0 \\ \cos x & \sin x-\cos x & 0 \\ \cos x & 0 & \sin x-\cos x \end{vmatrix}=0$$

$\Rightarrow (\sin x+2\cos x)(\sin x-\cos x)=0$

$\Rightarrow \tan x=1 \Rightarrow$ 1 solution

$\Rightarrow \tan x=-2 \Rightarrow$ 0 solution

Total 1 solution

Question: $\cot\left(\frac{\pi}{24}\right)=?$

Answer:

Solution:

$$\cot\left(\frac{\pi}{24}\right)=\cot(7.5)=\cot\left(\frac{15}{2}\right)$$

$$1+\cos(15)=1+\cos(45-30)=1+\left(\frac{1}{\sqrt{2}}\right)\left(\frac{\sqrt{3}}{2}\right)+\left(\frac{1}{\sqrt{2}}\right)\left(\frac{1}{2}\right)=\frac{\sqrt{3}+1+2\sqrt{2}}{2\sqrt{2}}$$

$$\sin^2 15=\sin^2(45-30)=\left(\frac{\sqrt{3}-1}{2\sqrt{2}}\right)^2=\frac{4-2\sqrt{3}}{8}=\frac{2-\sqrt{3}}{4}$$

$$\cot^2\left(\frac{15}{2}\right)=\frac{1+\cos 15}{1-\cos 15}=\frac{(1+\cos 15)^2}{\sin^2 15}=\frac{\left(2\sqrt{2}+\sqrt{3}+1\right)^2}{8\left(\frac{2-\sqrt{3}}{4}\right)}=\frac{\left(2\sqrt{2}+\sqrt{3}+1\right)^2}{4-2\sqrt{3}}$$

$$\cot\left(\frac{15}{2}\right)=\frac{\left(2\sqrt{2}+\sqrt{3}+1\right)}{\sqrt{4-2\sqrt{3}}}=\frac{\left(2\sqrt{2}+\sqrt{3}+1\right)}{\sqrt{3}-1}=\frac{\left(2\sqrt{2}+\sqrt{3}+1\right)\left(\sqrt{3}+1\right)}{2}=\sqrt{6}+\sqrt{2}+\sqrt{3}+\sqrt{4}$$

Question: Equation of circle $\mathrm{Re}\left(z^2\right)+2\left(\mathrm{img}(z)\right)^2+2\mathrm{Re}(z)=0$ where $z=x+iy$. A line passes through the vertex of parabola $x^2-6x+y+13=0$ and center of circle, then the y intercept of the line is___?

Answer: -1.00

Solution:

Equation of circle is $x^2-y^2+2y^2+2x=0$

$\Rightarrow x^2+y^2+2x=0$

$\Rightarrow$ centre (-1, 0)

Also, $(x-3)^2=-y-13+9=-(y+4)\Rightarrow$ vertex (3, -4)

$\therefore$ Equation of line passing through (-1, 0) & (3, -4) is

$y = \frac{-4}{4}(x+1) \Rightarrow x + y = -1$

$\therefore$ y-intercept of line = -1

Question: If $f(x) = \frac{P(x)}{\sin(x-2)}$, at $x = 2, p(x) = 7$. $P(x)$ is a polynomial where $P(3) = 9$.

Find $P(5)$.

Answer: 39.00

Solution:

$f(x) = \frac{P(x)}{\sin(x-2)}$

$P''(x) = c \Rightarrow P(x) = ax^2 + bx + c$

$P(2) = 0 \Rightarrow 4a + 2b + c = 0$

$P'(2) = 7 \Rightarrow 4a + b = 7$

$P(3) = 9 \Rightarrow 9a + 3b + c = 9$

$a = 2, b = -1, c = -6$

$\therefore P(x) = 2x^2 - x - 6$

$\Rightarrow P(5) = 39$

Question: $\left(2 + \frac{3}{x}\right)^n$ if coefficient of x^7 & x^8 is same

Answer: 55.00

Solution:

${}^nC_7 (2)^{n-7} \left(\frac{1}{3}\right)^7 = {}^nC_8 (2)^{n-8} \left(\frac{1}{3}\right)^8$

$\frac{{}^nC_8}{{}^nC_7} = 3 \cdot 2 = 6 = \frac{n-7}{8} \Rightarrow n = 55$

Question: Find the value of $\sum_{n=8}^{100} \left[\frac{(-1)^n n}{2}\right]$ where [x] greatest integer function n.

Answer: 4.00

Solution:

$S = 4 - 5 + 5 - 6 + 6 .... - 50 + 50 = 4$

Question: If $a\hat{i} + a\hat{j} + c\hat{k}, \hat{i} + \hat{k}$ and $c\hat{i} + c\hat{j} + b\hat{k}$ are coplanar then $c = ?$

Answer: ()

Solution:

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

$\Rightarrow -ac - a(b-c) + c^2 = 0$

$c^2 = ab$

$x = \sqrt{ab}$

Question: Find the number of irrational terms in $\left(2^{\frac{1}{3}} + 3^{\frac{1}{4}}\right)^{12}$.

Answer: 11.00

Solution:

$T_{r+1} = {}^{12}C_r \cdot (2)^{\frac{r}{3}} \cdot (3)^{\frac{12-r}{4}} = {}^{12}C_r \cdot (3)^3 \cdot (2)^{\frac{r}{3}} \cdot (3)^{\frac{-r}{4}}$

$\therefore$ Number of rational terms = 2 ($r = 0, 1, 2$)

$\therefore$ Number of irrational term = $13 - 2 = 11$