FINAL JEE–MAIN EXAMINATION – APRIL, 2024

(Held On Saturday 06 April, 2024) TIME : 3 : 00 PM to 6 : 00 PM

MATHEMATICS

TEST PAPER WITH SOLUTION

SECTION-A

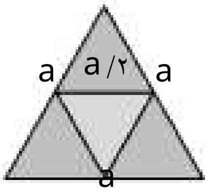
١. Let ABC be an equilateral triangle. A new triangle is formed by joining the middle points of all sides of the triangle ABC and the same process is repeated infinitely many times. If P is the sum of perimeters and Q is be the sum of areas of all the triangles formed in this process, then :

(١) $P^2 = ٧٢\sqrt{٣}Q$ (٢) $P^2 = ٣٦\sqrt{٣}Q$

(٣) $P = ٣٦\sqrt{٣}Q^2$ (٤) $P^2 = ٧٢\sqrt{٣}Q$

Ans. (١)

Sol.



Area of first $= \frac{\sqrt{٣}a^٢}{٤}$

Area of second $= \frac{\sqrt{٣}}{٤}\frac{a^٢}{٤} = \frac{\sqrt{٣}a^٢}{١٦}$

Area of third $= \frac{\sqrt{٣}a^٢}{٦٤}$

sum of area $= \frac{\sqrt{٣}a^٢}{٤}\left(1 + \frac{١}{٤} + \frac{١}{١٦} + \ldots\right)$

$Q = \frac{\sqrt{٣}a^٢}{٤} \cdot \frac{١}{\frac{٣}{٤}} = \frac{a^٢}{\sqrt{٣}}$

perimeter ofst١ $= ٣a$

perimeter ofnd٢ $= \frac{٣a}{٢}$

perimeter ofrd٣ $= \frac{٣a}{٤}$

$P = ٣a\left(١ + \frac{١}{٢} + \frac{١}{٤} + \ldots\right)$

$P = ٣a . ٢ = ٦a$

$a = \frac{P}{٦}$

$Q = \frac{١}{\sqrt{٣}} \cdot \frac{P^٢}{٣٦}$

$P^٢ = ٣٦\sqrt{٣}Q$

٢. Let A = {١, ٢, ٣, ٤, ٥}. Let R be a relation on A defined by xRy if and only if $٤x \le ٥y$. Let m be the number of elements in R and n be the minimum number of elements from A × A that are required to be added to R to make it a symmetric relation. Then m + n is equal to :

(١) ٢٤ (٢) ٢٣

(٣) ٢٥ (٤) ٢٦

Ans. (٣)

Sol. Given : $٤x \le ٥y$ then

R = {(١, ١), (١, ٢), (١, ٣), (١, ٤), (١, ٥), (٢, ٢), (٢, ٣), (٢, ٤), (٢, ٥), (٣, ٣), (٣, ٤), (٣, ٥), (٤, ٤), (٤, ٥), (٥, ٤), (٥, ٥)}

i.e. ١٦ elements. i.e. m = ١٦ Now to make R a symmetric relation add

{(٢, ١)(٣, ٢)(٤, ٣)(٣, ١)(٤, ٢)(٥, ٣)(٤, ١)(٥, ٢)(٥, ١)}

i.e. n = ٩

So m + n = ٢٥

٣. If three letters can be posted to any one of the ٥ different addresses, then the probability that the three letters are posted to exactly two addresses is :

(١) $\frac{١٢}{٢٥}$ (٢) $\frac{١٨}{٢٥}$

(٣) $\frac{٤}{٢٥}$ (٤) $\frac{٦}{٢٥}$

Ans. (١)

Sol. Total method $= ٥^٣$

faveable $= {}^٥C_٢ \left(٢^٣ - ٢\right) = ٦٠$

probability $= \frac{٦٠}{١٢٥} = \frac{١٢}{٢٥}$

٤. Suppose the solution of the differential equation $\frac{dy}{dx} = \frac{(2+\alpha)x - \beta y + 2}{\beta x - 2\alpha y - (\beta\gamma - 4\alpha)}$ represents a circle passing through origin. Then the radius of this circle is:

(1) $\sqrt{17}$ (2) $\frac{1}{2}$

(3) $\frac{\sqrt{17}}{2}$ (4) 2

Sol. Ans. (3)

$\frac{dy}{dx} = \frac{(2+\alpha)x - \beta y + 2}{\beta x - 2\alpha y - (\beta\gamma - 4\alpha)}$

$\Rightarrow \beta x dy - 2\alpha y dy - (\beta\gamma - 4\alpha) dy = (2+\alpha)x dx - \beta y dx + 2 dx$

$\Rightarrow \beta(x dy + y dx) - 2\alpha y dy - (\beta\gamma - 4\alpha) dy = (2+\alpha)x dx + 2 dx$

$\Rightarrow \beta xy - \alpha y^2 - (\beta\gamma - 4\alpha)y = \frac{(2+\alpha)x^2}{2} + 2x + c$

$c = 0$ for this to be circle

$\frac{(2+\alpha)x^2}{2} + \alpha y^2 + 2x - 4y = 0$

coeff. of $x^2 = y^2$: $2 + a = 2a$

$\Rightarrow \alpha = 2$

i.e. $2x^2 + 2y^2 + 2x - 8y = 0$

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

$r = \sqrt{\frac{1}{4} + 4} = \frac{\sqrt{17}}{2}$

٥. If the locus of the point, whose distances from the point (2, 1) and (1, 3) are in the ratio 5 : 4, is $ax^2 + by^2 + cxy + dx + ey + 170 = 0$, then the value of $a^2 + 2b + 3c + 4d + e$ is equal to:

(1) 5 (2) −27

(3) 37 (4) 437

Ans. (3)

Sol. let P(x, y)

$\frac{(x-2)^2 + (y-1)^2}{(x-1)^2 + (y-3)^2} = \frac{25}{16}$

$9x^2 + 9y^2 + 14x - 118y + 170 = 0$

$a^2 + 2b + 3c + 4d + e$

$= 81 + 18 + 0 + 56 - 118$

$= 155 - 118$

$= 37$

٦. $\lim_{n\to\infty} \frac{(1^2-1)(n-1) + (2^2-2)(n-2) + \dots + ((n-1)^2-(n-1))\cdot 1}{(1^3+2^3+\dots+n^3) - (1^2+2^2+\dots+n^2)}$ is equal to:

(1) $\frac{2}{3}$ (2) $\frac{1}{3}$

(3) $\frac{3}{4}$ (4) $\frac{1}{2}$

Ans. (2)

Sol. $\lim_{n\to\infty} \frac{\sum_{r=1}^{n}(r^2 - r)(n - r)}{\sum_{r=1}^{n} r^3 - \sum_{r=1}^{n} r^2}$

$\lim_{n\to\infty} \frac{\sum_{r=1}^{n-1}\left(-r^3 + r^2(n+1) - nr\right)}{\left(\frac{n(n+1)}{2}\right)^2 - \frac{n(n+1)(2n+1)}{6}}$

$\lim_{n\to\infty} \frac{-\left(\frac{(n-1)n}{2}\right)^2 + \frac{(n+1)(n-1)n(2n-1)}{6} - \frac{n^2(n-1)}{2}}{\frac{n(n+1)}{2}\left(\frac{n(n+1)}{2} - \frac{2n+1}{3}\right)}$

$\lim_{n\to\infty} \frac{\frac{n(n-1)}{2}\left(\frac{-n(n-1)}{2} + \frac{(n+1)(2n-1)}{3} - n\right)}{\frac{n(n+1)}{2}\cdot\frac{3n^2+3n-4n-2}{6}}$

$\lim_{n\to\infty} \frac{(n-1)\left(-3n^2+3n+2(2n^2+n-1)-6n\right)}{(n+1)(3n^2-n-2)}$

$\lim_{n\to\infty} \frac{(n-1)(n^2-n-2)}{(n+1)(3n^2-n-2)} = \frac{1}{3}$

٧. Let $0 \le r \le n$. If ${}^{n+1}C_{r+1} : {}^{n}C_{r} : {}^{n-1}C_{r-1} = 55 : 35 : 21$, then $2n + 5r$ is equal to:

(1) 60 (2) 62

(3) 50 (4) 55

Ans. (3)

Ans. $\frac{{}^{n+1}C_{r+1}}{{}^{n}C_{r}} = \frac{55}{35}$

$\frac{(n+1)!}{(r+1)!(n-r)!} \cdot \frac{r!(n-r)!}{n!} = \frac{11}{7}$

$\frac{n+1}{r+1} = \frac{11}{7}$

٧n = ٤ + ١١r

$$\frac{{}^{n}C_{r}}{{}^{n-١}C_{r-١}} = \frac{٣٥}{٢١}$$

$$\frac{n!}{r!(n-r)!} \times \frac{(r-١)!(n-r)!}{(n-١)!} = \frac{٥}{٣}$$

$$\frac{n}{r} = \frac{٥}{٣}$$

٣n = ٥r

By solving r = ٦   n = ١٠

٢n + ٥r = ٥٠

٨. A software company sets up m number of computer systems to finish an assignment in ١٧ days. If ٤ computer systems crashed on the start of the second day, ٤ more computer systems crashed on the start of the third day and so on, then it took ٨ more days to finish the assignment. The value of m is equal to:

(١) ١٢٥   (٢) ١٥٠

(٣) ١٨٠   (٤) ١٦٠

Ans. (٢)

Sol. ١٧m = m + (m − ٤) + (m − ٤ × ٢) . . . + . . . (m − ٤ × ٢٤)

١٧m = ٢٥m − ٤(١ + ٢ . . . ٢٤)

$$٨m = \frac{٤ \times ٢٤ \times ٢٥}{٢} \Rightarrow ١٥٠$$

٩. If z١, z٢ are two distinct complex number such that $\left|\frac{z_1 - ٢z_2}{\frac{١}{٢} - z_1\bar{z}_2}\right| = ٢$, then

(١) either z١ lies on a circle of radius ١ or z٢ lies on a circle of radius $\frac{١}{٢}$

(٢) either z١ lies on a circle of radius $\frac{١}{٢}$ or z٢ lies on a circle of radius ١.

(٣) z١ lies on a circle of radius $\frac{١}{٢}$ and z٢ lies on a circle of radius ١.

(٤) both z١ and z٢ lie on the same circle.

Ans. (١)

Sol. $$\frac{z_1 - ٢z_2}{\frac{١}{٢} - z_1\bar{z}_2} \cdot \frac{\bar{z}_1 - ٢\bar{z}_2}{\frac{١}{٢} - \bar{z}_1 z_2} = ٤$$

$$|z_1|^2 + ٤|z_2|^2 - ٢z_1\bar{z}_2 - ٢\bar{z}_1 z_2 = ٤\left(\frac{١}{٤} - \frac{\bar{z}_1 z_2}{٢} - \frac{z_1\bar{z}_2}{٢} + |z_1|^2|z_2|^2\right)$$

$$z_1\bar{z}_1 + ٤z_2\bar{z}_2 - ٤z_1\bar{z}_1 z_2\bar{z}_2 - ١ = ٠$$

$$(z_1\bar{z}_1 - ١)(١ - ٤z_2\bar{z}_2) = ٠$$

$$\left(|z_1|^2 - ١\right)\left(|z_2|^2 - \frac{١}{٤}\right) = ٠$$

١٠. If the function $f(x) = \left(\frac{١}{x}\right)^{٢x}$, x > ٠ attains the maximum value at $x = \frac{١}{e}$ then:

(١) $e^{\pi} < \pi^{e}$ (٢) $e^{٢\pi} < (٢\pi)^{e}$

(٣) $e^{\pi} > \pi^{e}$ (٤) $(٢e)^{\pi} > \pi^{(٢e)}$

Ans. (٣)

Sol. Let $y = \left(\frac{1}{x}\right)^{٢x}$

$\ln y = ٢x \ln\left(\frac{1}{x}\right)$

$\ln y = -٢x \ln x$

$$\frac{١}{y}\frac{dy}{dx} = -2(1 + \ln x)$$

for $x > \frac{١}{e}$ f is decreasing

so, e > [illegible]

$$\left(\frac{1}{e}\right)^{٢e} > \left(\frac{1}{\pi}\right)^{2\pi}$$

$e^{\pi} < \pi^{e}$

١١. Let $\vec{a} = ٢\hat{i} + \hat{j} - ٢\hat{k}$ and $\vec{b} = \hat{i} + \hat{j}$. If $\vec{c}$ is a vector such that $|\vec{c}| = ٦$, $\vec{a}\cdot\vec{c} = ٦$, $|\vec{c} - \vec{a}| = ٢\sqrt{٢}$ and the angle between $\vec{a} \times \vec{b}$ and $\vec{c}$ is ٦٠°, then $|(\vec{a} \times \vec{b}) \times \vec{c}|$ is equal to:

(١) $\frac{٩}{٢}(6 - \sqrt{6})$ (٢) $\frac{٣}{٢}\sqrt{٣}$

(٣) $\frac{٣}{٢}\sqrt{٦}$ (٤) $\frac{٩}{٢}(6 + \sqrt{6})$

Ans. (٤)

Sol. $|(a \times b) \times c| = |a \times b||c| \frac{\sqrt{٣}}{٢}$

$|c - a| = ٢\sqrt{٢}$

$|c|^٢ + |a|^٢ - ٢c \cdot a = ٨$

$|z|^٢ + ٣٨ - ١٢|z| = ٨$

$|z|^٢ - ١٢|z| + ٣٠ = ٠$

$|z| = \frac{١٢ \pm \sqrt{١٤٤-١٢٠}}{٢}$

$= \frac{١٢ \pm ٢\sqrt{٦}}{٢}$

$|z| = 6 \pm \sqrt{٦}$

$a \times b = \begin{vmatrix} \hat{\ell} & \hat{j} & \hat{k} \\ ٦ & ١ & -١ \\ ١ & ١ & ٠ \end{vmatrix}$

$\hat{\ell} - \hat{j} + ٥\hat{k}$

$|a \times b| = \sqrt{٢٧}$

$|(a \times b) \times z| = \sqrt{٢٧}(٦ \pm \sqrt{٦}) \frac{\sqrt{٣}}{٢}$

$\frac{٩}{٢}(٦ \pm \sqrt{٦})$

١٢. If all the words with or without meaning made using all the letters of the word "NAGPUR" are arranged as in a dictionary, then the word at ٣١٥th position in this arrangement is :

(١) NRAGUP (٢) NRAGPU

(٣) NRAPGU (٤) NRAPUG

Ans. (٣)

Sol. NAGPUR

A → ٥! = ١٢٠

G → ٥! = ١٢٠	٢٤٠
NA → ٤! = ٢٤	٢٦٤
NG → ٤! = ٢٤	٢٨٨
NP → ٤! = ٢٤	٣١٢
NRAGPU = ١	٣١٣
NRAGUP	٣١٤
NRAPGU	٣١٥

١٣. Suppose for a differentiable function h, h(٠) = ٠, h(١) = ١ and h'(٠) = h'(١) = ٢. If $g(x) = h(e^x) e^{h(x)}$, then g'(٠) is equal to :

(١) ٥ (٢) ٣

(٣) ٨ (٤) ٤

Ans. (٤)

Sol. $g(x) = h(e^x) e^{h(x)}$

$g'(x) = h(e^x) e^{h(x)} h'(x) + e^{h(x)} h'(e^x) e^x$

$g'(٠) = h(١) e^{h(٠)} h'(٠) + e^{h(٠)} h'(١)$

= ٢ + ٢ = ٤

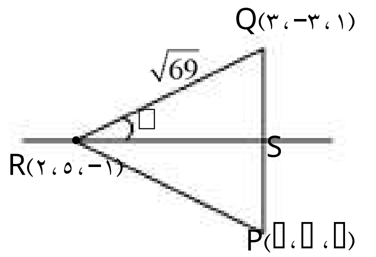
١٤. Let P(α, β, γ) be the image of the point Q(٣, −٣, ١) in the line $\frac{x-٠}{١} = \frac{y-٣}{١} = \frac{z-١}{-1}$ and R be the point (٢, ٥, −١). If the area of the triangle PQR is λ and $λ^٢ = ١٤K$, then K is equal to :

(١) ٣٦ (٢) ٧٢

(٣) ١٨ (٤) ٨١

Ans. (٤)

Sol.



$RQ = \sqrt{1 + ٦٤ + 4} = \sqrt{٦٩}$

$\vec{RQ} = \hat{\ell} - ٨\hat{j} + ٢\hat{k}$

$\vec{RS} = \hat{\ell} + \hat{j} - \hat{k}$

$\cos\theta = \left|\frac{\vec{RQ} \cdot \vec{RS}}{|RQ||RS|}\right| = \left|\frac{١ - ٨ - ٢}{\sqrt{٦٩}\sqrt{٣}}\right| = \frac{٩}{٣\sqrt{٢٣}}$

$\cos\theta = \frac{٣}{\sqrt{٢٣}} = \frac{RS}{RQ} = \frac{RS}{\sqrt{٦٩}}$

$RS = ٣\sqrt{٣}$

$\sin\theta = \frac{\sqrt{١٤}}{\sqrt{٢٣}} = \frac{QS}{\sqrt{٦٩}}$

$QS = \sqrt{٤٢}$

area $= \frac{١}{٢} \times ٢ QS \times RS = \sqrt{٤٢} \times ٣\sqrt{٣}$

$λ = ٩\sqrt{١٤}$

$λ^٢ = ٨١ \cdot ١٤ = ١٤k$

k = ٨١

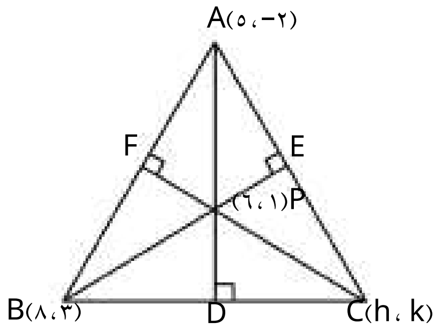
١٥. If P(٦، ١) be the orthocentre of the triangle whose vertices are A(٥، −٢)، B(٨، ٣) and C(h، k)، then the point C lies on the circle.

(١) $x^٢ + y^٢ - ٦٥ = ٠$ (٢) $x^٢ + y^٢ - ٧٤ = ٠$

(٣) $x^٢ + y^٢ - ٦١ = ٠$ (٤) $x^٢ + y^٢ - ٥٢ = ٠$

Ans. (١)

Sol.



Slope of AD = ٣

Slope of BC $= -\frac{١}{٣}$

equation of BC = ٣y + x − ١٧ = ٠

slope of BE = ١

Slope of AC = −١

equation of AC is x + y − ٣ = ٠

point C is (−٤، ٧)

١٦. Let $f(x) = \frac{١}{7 - \sin ٥x}$ be a function defined on R.

Then the range of the function f(x) is equal to:

(١) $\left[\frac{١}{٨}, \frac{١}{٥}\right]$ (٢) $\left[\frac{١}{٧}, \frac{١}{٦}\right]$

(٣) $\left[\frac{١}{٧}, \frac{١}{٥}\right]$ (٤) $\left[\frac{١}{٨}, \frac{١}{٦}\right]$

Ans. (٤)

Sol. $\sin ٥x \in [-١, ١]$

$-\sin ٥x \in [-١, ١]$

$٧ - \sin ٥x \in [٦, ٨]$

$\frac{١}{٧ - \sin ٥x} \in \left[\frac{١}{٨}, \frac{١}{٦}\right]$

١٧. Let $\vec{a}$ □ $\hat{j}$ □ $\hat{k}$ ، $\vec{b}$ □ □ $\vec{a}$ □ $\hat{i}$ □ $\hat{j}$ □ □ □

Then the square of the projection of $\vec{a}$ on $\vec{b}$ is:

(١) $\left(\frac{١}{٥}\right)^٢$ (٢) ٢

(٣) $\frac{١}{٣}$ (٤) $\frac{٢}{٣}$

Ans. (٢)

Sol. $\vec{a} \times (\hat{i} + \hat{j}) = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ ٢ & ١ & -١ \\ ١ & ١ & ٠ \end{vmatrix}$

$= \hat{i} - \hat{j} + \hat{k}$

□ $\vec{a}$ □ $\hat{i}$ □ $\hat{j}$ □ □ □ $\hat{k}$ □ $\hat{j}$

□ $\vec{a}$ □ $\hat{i}$ □ $\hat{j}$ □ $\hat{i}$ □ □ $\hat{j}$ $\hat{k}$ □

projection of $\vec{a}$ on $\hat{b} = \frac{\vec{a} \cdot \vec{b}}{|\vec{b}|}$

$= \frac{١ + ١}{\sqrt{٢}} = \sqrt{٢}$

١٨. If the area of the region

$\left\{(x, y) : \frac{a}{x^٢} \le y \le \frac{١}{x}, ١ \le x \le ٢, ٠ < a < 1\right\}$ is

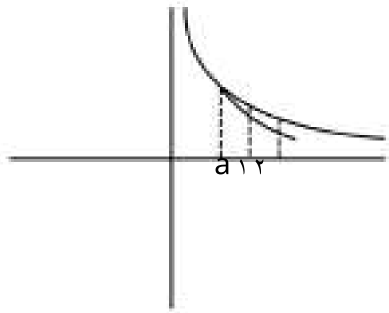
$(\log_e ٢) - \frac{١}{٧}$ then the value of ٧a − ٣ is equal to:

(١) ٢ (٢) ٠

(٣) −١ (٤) ١

Ans. (٣)

Sol.



area $= \int_{١}^{٢}\left(x - \frac{a}{x^{٢}}\right)dx$

$\left[\ell n x + \frac{a}{x}\right]_{1}^{٢}$

$\ell n ٢ + \frac{a}{٢} - a = \log_e ٢ - \frac{١}{٧}$

$\frac{-a}{٢} = -\frac{١}{٧}$

$a = \frac{٢}{٧}$

$٧a = ٢$

$٧a - ٣ = -١$

١٩. If $\int \frac{١}{a^{٢}\sin^{٢}x + b^{٢}\cos^{٢}x}dx = \frac{١}{١٢}\tan^{-١}(٣\tan x) +$ constant, then the maximum value of $a\sin x + b\cos x$, is :

(١) $\sqrt{٤٠}$ (٢) $\sqrt{٣٩}$

(٣) $\sqrt{٤٢}$ (٤) $\sqrt{٤١}$

Ans. (١)

Sol. $\int \frac{\sec^{٢}x\,dx}{a^{٢}\tan^{٢}x + b^{٢}}$

let $\tan x = t$

$\sec^{2}x\,dx = dt$

$\int \frac{dt}{a^{٢}t^{٢} + b^{٢}}$

$\frac{١}{a^{٢}}\int \frac{dt}{t^{٢} + \left(\frac{b}{a}\right)^{٢}}$

$\frac{١}{a^{٢}}\cdot\frac{١}{\frac{b}{a}}\tan^{-١}\left(\frac{t}{\frac{b}{a}}\right) + c$

$\frac{١}{ab}\tan^{-١}\left(\frac{a}{b}\tan x\right) + c$

on comparing $\frac{a}{b} = ٣$

$ab = ١٢$

$a = ٦, b = ٢$

maximum value of

$٦\sin x + ٢\cos x$ is $\sqrt{٤٠}$

٢٠. If A is a square matrix of order ٣ such that $\det(A) = ٣$ and

$\det(\text{adj}(-٤\,\text{adj}(-٣\,\text{adj}(٣\,\text{adj}((٢A)^{-١}))))) = ٢^{m}٣^{n}$, then $m + ٢n$ is equal to :

(١) ٣ (٢) ٢

(٣) ٤ (٤) ٦

Ans. (٣)

Sol. $|A| = ٣$

$\left|\text{adj}(-٤\,\text{adj}(-٣\,\text{adj}(٣\,\text{adj}((٢A)^{-١}))))\right|$

$= \left|-٤\,\text{adj}(-٣\,\text{adj}(٣\,\text{adj}(٢A)^{-١}))\right|^{٢}$

$= ٤^{٦}\left|\text{adj}(-٣\,\text{adj}(٣\,\text{adj}(٢A)^{-١}))\right|^{٢}$

$= ٢^{١٢}\cdot ٣^{١٢}\left|٣\,\text{adj}(٢A)^{-١}\right|^{٨}$

$= ٢^{١٢}\cdot ٣^{١٢}\cdot ٣^{٢٤}\left|\text{adj}(٢A)^{-١}\right|^{٨}$

$= ٢^{١٢}\cdot ٣^{٣٦}\left|(٢A)^{-١}\right|^{١٦}$

$= ٢^{١٢}\cdot ٣^{٣٦}\frac{١}{|٢A|^{١٦}}$

$= ٢^{١٢}\cdot ٣^{٣٦}\frac{١}{٢^{٤٨}|A|^{١٦}}$

$= ٢^{١٢}\cdot ٣^{٣٦}\frac{١}{٢^{٤٨}\cdot ٣^{١٦}}$

$\frac{٣^{٢٠}}{٢^{٣٦}} = ٢^{-٣٦}\cdot ٣^{٢٠}$

$m = -٣٦ \quad n = ٢٠$

$m + ٢n = ٤$

SECTION-B

٢١. Let [t] denote the greatest integer less than or equal to t. Let f : [٠, ∞) → R be a function defined by $f(x) = \left[\frac{x}{2} + 3\right] - [\sqrt{x}]$. Let S be the set of all points in the interval [٠, ٨] at which f is not continuous. Then $\sum_{a \in S} a$ is equal to ______________.

Ans. (١٧)

Sol. $\left[\frac{x}{2} + 3\right]$ is discontinuous at x = ٢, ٤, ٦, ٨

$[\sqrt{x}]$ is discontinuous at x = ١, ٤

F(x) is discontinuous at x = ١, ٢, ٦, ٨

$\Rightarrow \sum a = ١ + ٢ + ٦ + ٨ = ١٧$

٢٢. The length of the latus rectum and directrices of a hyperbola with eccentricity e are ٩ and $x = \pm \frac{٤}{\sqrt{٣}}$, respectively. Let the line $y - \sqrt{٣}x + \sqrt{٣} = ٠$ touch this hyperbola at (x٠, y٠). If m is the product of the focal distances of the point (x٠, y٠), then ٤e + m is equal to __________.

NTA Ans. (٦١)

Ans. (Bonus)

Sol. Given $\frac{٢b^٢}{a} = ٩$ and $\frac{a}{e} = \pm \frac{٤}{\sqrt{٣}}$

equation of tangent $y - \sqrt{٣}x + \sqrt{٣} = ٠$

by equation of tangent

Let slope = S = $\sqrt{٣}$

Constant = $-\sqrt{٣}$

By condition of tangency

$\Rightarrow ٦ = ٦a - ٤a$

$\Rightarrow a = ٢,\ b = \frac{٢}{٩}$

Equation of Hyperbola is

$\frac{x^٢}{٤} - \frac{y^٢}{٩} = ١$ and for tangent

Point of contact is $(٤, ٣\sqrt{٣}) = (x_٠, y_٠)$

Now $e = \sqrt{1 + \frac{٩}{٤}} = \frac{\sqrt{١٣}}{٢}$

Again product of focal distances

m = (x٠e + a)(x٠e – a)

$m + ٤e = x_٠^٢ e^٢ - a^٢$

$= ٢٠ \times \frac{١٣}{٤} - ٤ = ٦١$

(There is a printing mistake in the equation of directrix $x = \pm \frac{٤}{\sqrt{٣}}$.

Corrected equation is $x = \pm \frac{٤}{\sqrt{١٣}}$ for directrix, as eccentricity must be greater than one, so question must be bonus)

٢٣. If $S(x) = (١ + x) + ٢(١ + x)^٢ + ٣(١ + x)^٣ + \ldots + ٦٠(١ + x)^{٦٠}$, x ≠ ٠, and (٦٠)S(٦٠) = a(b)^b + b, where a, b ∈ N, then (a + b) equal to ________

Ans. (٣٦٦٠)

Sol. $S(x) = (١+x) + ٢(١+x)^٢ + ٣(١+x)^٣ + \ldots + ٦٠(١ + x)^{٦٠}$

$(١+x)S = (١+x)^٢ + \ldots\ldots + ٥٩(١+x)^{٦٠} + ٦٠(١+x)^{٦١}$

$\Rightarrow xS = \frac{(1 + x)\left((1 + x)^{60} - 1\right)}{x} - 60(1 + x)^{61}$

Put x = ٦٠

$\Rightarrow ٦٠S = \frac{٦١(61^{60} - 1)}{٦٠} - ٦٠(٦١)^{٦١}$

on solving ٣٦٦٠

٢٤. Let [t] denote the largest integer less than or equal to t. If

$\int_٠^3 \left(\left[x^2\right] + \left[\frac{x^2}{2}\right]\right) dx = a + b\sqrt{2} - \sqrt{3} - \sqrt{5} + c\sqrt{6} - \sqrt{7}$,

where a, b, c ∈ Z, then a + b + c is equal to ________

Ans. (٢٣)

Sol. $\int_٠^٣ [x^٢] dx + \int_٠^٣ \left[\frac{x^٢}{٢}\right] dx$

$= \int_٠^١ ٠\, dx + \int_١^{\sqrt{٢}} ١\, dx + \ldots dx$

$□\int_{\sqrt{٣}}^{٢}□٢dx □ \int_{٢}^{\sqrt{٥}}□٤dx □ \int_{\sqrt{٥}}^{\sqrt{٦}}□٥dx$

$□\int_{\sqrt{٦}}^{\sqrt{٧}}□٦dx □ \int_{\sqrt{٧}}^{\sqrt{٨}}□٧dx □ \int_{\sqrt{٨}}^{٣}□٨dx$

$□\int_{٠}^{\sqrt{٣}}□dx □ \int_{\sqrt{٣}}^{٢}□dx$

$+\int_{٢}^{\sqrt{٣}}□٢dx □ \int_{\sqrt{٣}}^{\sqrt{٨}}□٧dx + \int_{\sqrt{٨}}^{٣}□٤dx□٣١□ ٦\sqrt{٢} □\sqrt{٣} □\sqrt{٥}$

$□2\sqrt{6}□\sqrt{٧}$

a = ٣١ b = −٦ c = −٢

a + b + c = ٣١ − ٦ − ٢ = ٢٣

٢٥. From a lot of ١٢ items containing ٣ defectives، a sample of ٥ items is drawn at random. Let the random variable X denote the number of defective items in the sample. Let items in the sample be drawn one by one without replacement. If variance of X is $\frac{m}{n}$، where gcd(m، n) = ١، then n − m is equal to ____________.

Ans. (٧١)

Sol. $a□1□\frac{{}^{٣}C_{٥}}{{}^{١٢}C_{٥}}$

$b□٣.\frac{{}^{٩}C_{٤}}{{}^{١٢}C_{٥}}$

$c□٣.\frac{{}^{٩}□_{٣}}{{}^{١٢}C_{٥}}$

$d□١.\frac{{}^{٩}C_{٢}}{{}^{١٢}C_{٥}}$

u = ٠.a + ١.b + ٢.c + ٣.d = ١.٢٥

$□^{٢}$ = ٠.a + ١.b + ٤.c + ٩d − u ٢

$□2□\frac{١٠٥}{١٧٦}$

Ans. ١٧٦ − ١٠٥ = ٧١

٢٦. In a triangle ABC، BC = ٧، AC = ٨، AB = □□□□ and cosA = $\frac{٢}{٣}$. If ٤٩cos(٣C) + ٤٢ = $\frac{m}{n}$، where gcd(m، n) = ١، then m + n is equal to ____________

Ans. (٣٩)

٢٦. In a triangle ABC، BC = ٧، AC = ٨، AB = □□□□ and cosA = $\frac{٢}{٣}$. If ٤٩cos(٣C) + ٤٢ = $\frac{m}{n}$، where gcd(m، n) = ١، then m + n is equal to ____________

Ans. (٣٩)

Sol. $\cos A□\frac{b^{٢}□c^{٢}□a^{٢}}{٢bc}$

$\frac{٢}{٣}□\frac{٨٢□c٢□٧٢}{٢□٨□c}$

C = ٩

$\cos C□\frac{7^{٢}□8^{٢}□9^{٢}}{٢□٧□٨}□\frac{٢}{٧}$

٤٩ cos٣C + ٤٢

٤٩(٤ cos³C − ٣ cosC) + ٤٢

$٤٩□٤□\left(\frac{2}{٧}\right)^{٣}□3□\frac{2}{٧}□□42$

$□\frac{٣٢}{٧}$

m + n = ٣٢ + ٧ = ٣٩

٢٧. If the shortest distance between the lines $\frac{x□□}{٣}□\frac{y□٢}{□1}□\frac{z□١}{١}$ and $\frac{x□٢}{□3}□\frac{y□٥}{٢}□\frac{z□٤}{٤}$ is $\frac{٤٤}{\sqrt{٣٠}}$، then the largest possible value of |□| is equal to ____________.

Ans. (٤٣)

Sol. $a_{١}□□\hat{i}□٢\hat{j}□\hat{k}$

$a_{٢}□□٢\hat{i}□٥\hat{j}□٤\hat{k}$

$p□□٣\hat{i}□\hat{j}□\hat{k}$

$q□□□٣\hat{i}□٢\hat{j}□٤\hat{k}$

$□□□٢□\hat{i}□٧\hat{j}□٣\hat{k}□a_{١}□a_{٢}$

$p□q□□□٦\hat{i}□١٥\hat{j}□٣\hat{k}$

$\frac{٤٤}{\sqrt{٣٠}} □ \frac{|□6□□١٢ □١٠٥ □٩|}{\sqrt{□□6□ ١٥□□٣٢}}$

$\frac{٤٤}{\sqrt{٣٠}} □ \frac{|٦□□١٢٦|}{٣\sqrt{٣٠}}$

١٣٢□٦□□١٢٦

$□ = ١ ، □ = -٤٣$

$|□| = ٤٣$

٢٨. Let □، be roots of $x^٢ □ \sqrt{٢}x - ٨ □ ٠$.

If $U_n □□^n □□^n$، then $\frac{U_{١٠} □ \sqrt{١٢}U_٩}{٢U_٨}$ is equal to __________.

Ans. (٤)

Sol. $\frac{□^{١٠} □□ □\sqrt{٢}□^٩ □□^٩ □}{2□^٨ □ □^٨ □}$

$\frac{□8 □\sqrt{٢}□2□□□8 □\sqrt{٢}□□2 □}{٢□□8 □□8□}$

$\frac{٨□8 □ 8□8□٤}{2□8□□8□}$

٢٩. If the system of equations ٢x + ٧y + □z = ٣ ٣x + ٢y + ٥z = ٤ x + □y + ٣٢z = −١ has infinitely many solutions، then (□ − □) is equal to __________ : Ans. (٣٨)

Sol. D = D١ = D٢ = D٣ = ٠

$D_٣ = \begin{vmatrix} ٢ & ٧ & ٣ \\ ٣ & ٢ & ٤ \\ ١ & □ & □١ \end{vmatrix} □0□□□□39$

$D □\begin{vmatrix} ٢ & ٧ & □ \\ ٣ & ٢ & ٥ \\ ١ & □٣٩ & ٣٢ \end{vmatrix} □0□□□□1$

□□□□٣٨

٣٠. If the solution y(x) of the given differential equation $(e^y + ١) \cos x\, dx + e^y \sin x\, dy = ٠$ passes through the point $□\frac{□}{2}، ٠□$، then the value of $e^{y□\frac{□}{٦}□}$ is equal to __________.

Ans. (٣)

Sol. $(e^y + ١) \cos x\, dx + e^y \sin x\, dy = ٠$

$□d□□e^y□١□\sin x□ = ٠$

$□e^y□١□\sin x□C$

It passes through $□\frac{□}{2}،٠□$

$□c□٢$

Now، $x□\frac{□}{٦}$

$□e^y□٣$

PHYSICS — TEST PAPER WITH SOLUTION

SECTION–A

٣١. The longest wavelength associated with Paschen series is : (Given RH = ١.٠٩٧ × ١٠٧ SI unit)

(١) ١.٠٩٤ × ١٠ m⁻٦ (٢) ٢.٩٧٣ × ١٠ m⁻٦

(٣) ٣.٦٤٦ × ١٠ m⁻٦ (٤) ١.٨٧٦ × ١٠ m⁻٦

Ans. (٤)

Sol. For longest wavelength in Paschen's series:

$\frac{1}{\lambda} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$

For longest n١ = ٣

n٢ = ٤

$\frac{1}{\lambda} = R\left(\frac{1}{(3)^2} - \frac{1}{(4)^2}\right)$

$\frac{1}{\lambda} = R\left(\frac{1}{9} - \frac{1}{16}\right)$

$\frac{1}{\lambda} = R\left(\frac{7}{9 \times 16}\right)$

$\lambda = \frac{16 \times 9}{7R} = \frac{16 \times 9}{7 \times 1.097 \times 10^7}$

$\lambda = 1.876 \times 10^{-6}$ m

٣٢. A total of ٤٨ J heat is given to one mole of helium kept in a cylinder. The temperature of helium increases by ٢°C. The work done by the gas is : (Given, R = ٨.٣ J K⁻¹ mol.)⁻¹

(١) ٧٢.٩ J (٢) ٢٤.٩ J

(٣) ٤٨ J (٤) ٢٣.١ J

Ans. (٤)

Sol. ١st law of thermodynamics

$\Delta Q = \Delta U + W$

$\Rightarrow +48 = nC_v\Delta T + W$

$\Rightarrow 48 = (1)\left(\frac{3R}{2}\right)(2) + W$

$\Rightarrow W = 48 - 3 \times R$

$\Rightarrow W = 48 - 3 \times (8.3)$

$\Rightarrow W = 23.1$ Joule

٣٣. In finding out refractive index of glass slab the following observations were made through travelling microscope ٥٠ vernier scale division = ٤٩ MSD; ٢٠ divisions on main scale in each cm

For mark on paper

MSR = ٨.٤٥ cm, VC = ٢٦

For mark on paper seen through slab

MSR = ٧.١٢ cm, VC = ٤١

For powder particle on the top surface of the glass slab

MSR = ٤.٠٥ cm, VC = ١

(MSR = Main Scale Reading, VC = Vernier Coincidence)

Refractive index of the glass slab is:

(١) ١.٤٢ (٢) ١.٥٢

(٣) ١.٢٤ (٤) ١.٣٥

Ans. (١)

Sol. ١ MSD = $\frac{1\text{cm}}{20}$ = ٠.٠٥ cm

١ VSD = $\frac{49}{50}$ MSD = $\frac{49}{50}$ × ٠.٠٥ cm = ٠.٠٤٩ cm

LC = ١MSD – ١VSD = ٠.٠٠١ cm

For mark on paper, L١ = ٨.٤٥ cm + ٢٦ × ٠.٠٠١ cm = ٨٤.٧٦ mm

For mark on paper through slab, L٢ = ٧.١٢ cm + ٤١× ٠.٠٠١ cm = ٧١.٦١ mm

For powder particle on top surface, ZE = ٤.٠٥ cm + ١ × ٠.٠٠١ cm = ٤٠.٥١ mm

$\Rightarrow$ actual L١ = ٨٤.٧٦ – ٤٠.٥١ = ٤٤.٢٥ mm

actual L٢ = ٧١.٦١ – ٤٠.٥١ = ٣١.١٠ mm

$L_2 = \frac{L_1}{\mu}$

$\Rightarrow \mu = \frac{L_1}{L_2} = \frac{44.25}{31.10} = 1.42$

٣٤. In the given electromagnetic wave $E_y = ٦٠٠ \sin(\omega t - kx)$ V/m, intensity of the associated light beam is (in W/m²); (Given $\varepsilon_0 = ٩\times ١٠^{-١٢}\ C^2N^{-1}m^{-2}$)

(١) ٤٨٦ (٢) ٢٤٣
(٣) ٧٢٩ (٤) ٩٧٢

Ans. (١)

Sol. Intensity $= \frac{١}{٢}\varepsilon_0 E_0^2 c$

$= \frac{١}{٢} \times ٩ \times ١٠^{-١٢} \times (٦٠٠)^2 \times ٣ \times ١٠^{٨}$

$= \frac{٩}{٢} \times ٣٦ \times ٣ = ٤٨٦\ W/m^2$

٣٥. Assuming the earth to be a sphere of uniform mass density, a body weighed ٣٠٠ N on the surface of earth. How much it would weigh at R/٤ depth under surface of earth?

(١) ٧٥ N (٢) ٣٧٥ N
(٣) ٣٠٠ N (٤) ٢٢٥ N

Ans. (٤)

Sol. At surface: mg = ٣٠٠ N

$m = \frac{٣٠٠}{g_s}$

At Depth $\frac{R}{٤}$: $g_d = g_s\left(1 - \frac{d}{R}\right)$

$g_d = g_s\left(1 - \frac{R}{٤R}\right)$

$g_d = \frac{٣g_s}{٤}$

weight at depth $= m \times g_d$

$= m \times \frac{٣g_s}{٤}$

$= \frac{٣}{٤} \times ٣٠٠$

$= ٢٢٥$ N

٣٦. The acceptor level of a p-type semiconductor is ٦eV. The maximum wavelength of light which can create a hole would be: Given hc = ١٢٤٢ eV nm.

(١) ٤٠٧ nm (٢) ٤١٤ nm
(٣) ٢٠٧ nm (٤) ١٠٣.٥ nm

Ans. (٣)

Sol. Energy $= \frac{hc}{\lambda}$,

$E = \frac{١٢٤٠}{\lambda(nm)}$ eV

$6 = \frac{١٢٤٠}{\lambda(nm)}$

$\lambda = \frac{١٢٤٠}{٦} = ٢٠٧$ nm

٣٧. A car of ٨٠٠ kg is taking turn on a banked road of radius ٣٠٠ m and angle of banking ٣٠°. If coefficient of static friction is ٠.٢ then the maximum speed with which car can negotiate the turn safely: (g = ١٠ m/s², $\sqrt{٣}$ = ١.٧٣)

(١) ٧٠.٤ m/s (٢) ٥١.٤ m/s
(٣) ٢٦٤ m/s (٤) ١٠٢.٨ m/s

Ans. (٢)

Sol. m = ٨٠٠ kg

r = ٣٠٠ m

θ = ٣٠°

μ_s = ٠.٢

$V_{max} = \sqrt{Rg\left(\frac{\tan\theta + \mu}{1 - \mu\tan\theta}\right)}$

$= \sqrt{٣٠٠ \times g \left(\frac{\tan ٣٠° + ٠.٢}{١ - ٠.٢\tan ٣٠°}\right)}$

$= \sqrt{٣٠٠ \times ١٠ \left(\frac{٠.٥٧ + ٠.٢}{١ - ٠.٢ \times ٠.٥٧}\right)}$

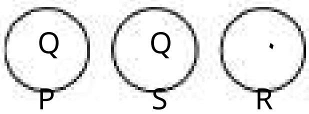
Vmax = ٥١.٤ m/s

٣٨. Two identical conducting spheres P and S with charge Q on each, repel each other with a force ١٦N. A third identical uncharged conducting sphere R is successively brought in contact with the two spheres. The new force of repulsion between P and S is:

(١) ٤ N (٢) ٦ N
(٣) ١ N (٤) ١٢ N

Ans. (٢)

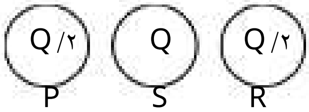
Sol.



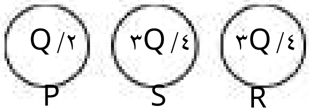
$F_{PS} \propto Q^{٢}$

$F_{PS} = ١٦$ N

Now If P & R are brought in contact then



Now If S & R are brought in contact then



New force between P & S is :

$F_{PS} \propto \frac{Q}{٢} \times \frac{٣Q}{٤}$

$F_{PS} \propto \frac{٣Q^{٢}}{٨} = \frac{٣}{٨} \times ١٦ = ٦N$

٣٩. In a coil، the current changes form −٢ A to +٢A in ٠.٢ s and induces an emf of ٠.١ V. The self-inductance of the coil is :

(١) ٥ mH (٢) ١ mH

(٣) ٢.٥ mH (٤) ٤ mH

Ans. (١)

Sol. $(Emf)_{induced} = -L\frac{di}{dt}$

In magnitude form،

$|Emf_{ind}| = |(-)L\frac{di}{dt}|$

$\Rightarrow ٠.١ = \frac{(L)(٢-(-٢))}{٠.٢}$

$\Rightarrow L = \frac{٠.١ \times ٠.٢}{٤} = ٥mH$

٤٠. For the thin convex lens، the radii of curvature are at ١٥ cm and ٣٠ cm respectively. The focal length the lens is ٢٠ cm. The refractive index of the material is :

(١) ١.٢ (٢) ١.٤

(٣) ١.٥ (٤) ١.٨

Ans. (٣)

Sol. $\frac{١}{f} = \left(\frac{\mu_{lens}}{\mu_{air}} - 1\right)\left(\frac{١}{R_{١}} - \frac{١}{R_{٢}}\right)$

$\Rightarrow \frac{١}{٢٠} = \left(\frac{\mu}{1} - 1\right)\left(\frac{١}{١٥} - \frac{١}{(-٣٠)}\right)$

$\Rightarrow \frac{١}{٢٠} = (\mu - ١)\left(\frac{٣}{٣٠}\right)$

$\Rightarrow \mu - ١ = \frac{١}{٢}$

$\Rightarrow \mu = 1 + \frac{١}{٢} = \frac{٣}{٢} = ١.٥$

٤١. Energy of ١٠ non rigid diatomic molecules at temperature T is :

(١) $\frac{٧}{٢}$ RT (٢) ٧٠ KBT

(٣) ٣٥ RT (٤) ٣٥ KBT

Ans. (٤)

Sol. Degree of freedom(f) = ٥ + ٢(٣N − ٥)

f = ٥ + ٢(٣ × ٢ − ١) = ٧

energy of one molecule $= \frac{f}{٢}K_{B}T$

energy of ١٠ molecules

$= ١٠\left(\frac{f}{2}K_{B}T\right) = ١٠\left(\frac{7}{2}KT\right) = ٣٥$ KBT

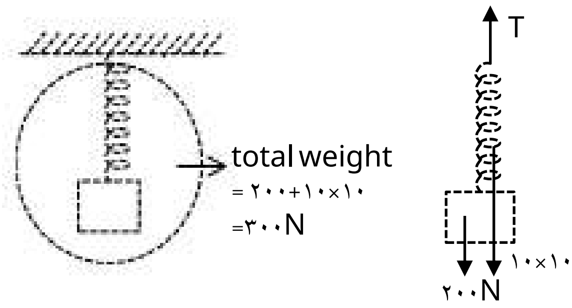
٤٢. A body of weight ٢٠٠ N is suspended form a tree branch thought a chain of mass ١٠ kg. The branch pulls the chain by a force equal to (if g = ١٠ m/s):

(١) ١٥٠ N (٢) ٣٠٠ N

(٣) ٢٠٠ N (٤) ١٠٠ N

Ans. (٢)

Sol.



Chain block system is in equilibrium so

T = ٢٠٠ + ١٠٠ = ٣٠٠ N.

٤٣. When UV light of wavelength ٣٠٠ nm is incident on the metal surface having work function ٢.١٣ eV، electron emission takes place. The stopping potential is : (Given hc = ١٢٤٠ eV nm)

(١) ٤ V (٢) ٤.١ V (٣) ٢ V (٤) ١.٥ V

Ans. (٣)

Sol. $\frac{hc}{\lambda} - \phi = e.V_s$

$\frac{١٢٤٠}{٣٠٠}$ eV − ٢.١٣ eV = eVs

⇒ ٤.١٣ eV − ٢.١٣ eV = eVs.

⇒ So، V_s = ٢ volt

٤٤. The number of electrons flowing per second in the filament of a ١١٠ W bulb operating at ٢٢٠ V is : (Given e = ١.٦ × ١٠ $^{-١٩}$ C)

(١) ٣١.٢٥ × ١٠ ^{١٧} (٢) ٦.٢٥ × ١٠ ^{١٨}

(٣) ٦.٢٥ × ١٠ ^{١٧} (٤) ١.٢٥ × ١٠ ^{١٩}

Ans. (١)

Sol. Power (P) = V.I

⇒ ١١٠ = (٢٢٠) (I)

⇒ I = ٠.٥ A

Now، I = $\frac{n e}{t}$

⇒ ٠.٥ = $\left(\frac{n}{t}\right)$ (١.٦ × ١٠) $^{-١٩}$

⇒ $\frac{n}{t}$ = $\frac{٠.٥}{١.٦ \times ١٠^{-١٩}}$

⇒ $\frac{n}{t}$ = ٣١.٢٥ × ١٠ ^{١٧}

٤٥. When kinetic energy of a body becomes ٣٦ times of its original value، the percentage increase in the momentum of the body will be :

(١) ٥٠٠٪ (٢) ٦٠٠٪

(٣) ٦٪ (٤) ٦٠٪

Ans. (١)

Sol. Kinetic energy (K) = $\frac{P^٢}{٢m}$

⇒ P = $\sqrt{٢mK}$

If Kf = ٣٦ Ki

So، Pf = ٦ Pi

٪ increase in momentum = $\frac{P_f - P_i}{P_i}$ × ١٠٠٪

= $\frac{٦P_i - P_i}{P_i}$ × ١٠٠٪

= ٥٠٠٪

٤٦. Pressure inside a soap bubble is greater than the pressure outside by an amount :
(given : R = Radius of bubble، S = Surface tension of bubble)

(١) $\frac{٤S}{R}$ (٢) $\frac{٤R}{S}$

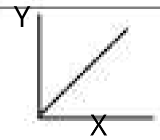
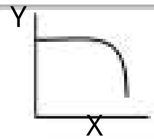
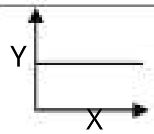
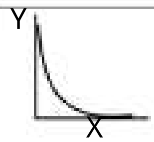
(٣) $\frac{S}{R}$ (٤) $\frac{٢S}{R}$

Ans. (١)

Sol. There are two liquid-air surfaces in bubble so

$\Delta P = 2\left(\frac{٢S}{R}\right) = \frac{٤S}{R}$

٤٧. Match List-I with List-II

	List-I (Y vs X)		List-II (Shape of Graph)
(A)	Y = magnetic susceptibility X = magnetising field	(I)	
(B)	Y = magnetic field X = distance from centre of a current carrying wire for x > a (where a=radius of wire)	(II)	
(C)	Y = magnetic field X = distance from centre of a current carrying wire for x < a (where a = radius of wire)	(III)	
(D)	Y= magnetic field inside solenoid X = distance from center	(IV)	

Choose the correct answer from the options given below :

(١) (A)-(III)، (B)-(I)، (C)-(IV)، (D)-(II)

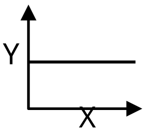
(٢) (A)-(I)، (B)-(III)، (C)-(II)، (D)-(IV)

(٣) (A)-(IV)، (B)-(I)، (C)-(III)، (D)-(II)

(٤) (A)-(III)، (B)-(IV)، (C)-(I)، (D)-(II)

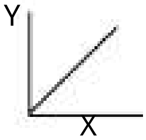
Ans. (٤)

Sol. (A) Graph between Magnetic susceptibility and magnetising field is :



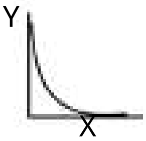
(B) magnetic field due to a current carrying wire for x a :

$B = \frac{\mu_0 i r}{2\pi a^2}$

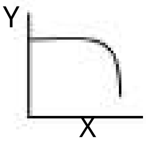


(C) magnetic field due to a current carrying wire for x a :

$B = \frac{\mu_0 i}{2\pi a}$



(D) magnetic field inside solenoid varies as :



٤٨. In a vernier calliper, when both jaws touch each other, zero of the vernier scale shifts towards left and its ٤th division coincides exactly with a certain division on main scale. If ٥٠ vernier scale divisions equal to ٤٩ main scale divisions and zero error in the instrument is ٠.٠٤ mm then how many main scale divisions are there in ١ cm?

(١) ٤٠ (٢) ٥

(٣) ٢٠ (٤) ١٠

NTA Ans. (٣)

Sol. ٤th division coincides with ٣rd division then

٠.٠٠٤ cm = ٤VSD − ٣MSD

٤٩MSD = ٥٠ VSD

$١MSD = \frac{١}{N}$ cm

$٠.٠٠٤ = ٤ \times \frac{٤٩}{٥٠} MSD - ٣MSD$

$٠.٠٠٤ = \left[\frac{١٩٦}{٥٠} - 3\right]\left[\frac{1}{N}\right]$

$N = \frac{٤٦}{٥٠} \times \frac{١٠٠٠}{٤} = \frac{٤٦ \times ١٠٠٠}{٢٠٠} = ٢٣٠$

٤٩. Given below are two statements :

Statement (I) : Dimensions of specific heat is $[L^2T^{-2}K^{-1}]$

Statement (II) : Dimensions of gas constant is $[M^1L^2T^{-1}K^{-1}]$

(١) Statement (I) is incorrect but statement (II) is correct

(٢) Both statement (I) and statement (II) are incorrect

(٣) Statement (I) is correct but statement (II) is incorrect

(٤) Both statement (I) and statement (II) are correct

Ans. (٣)

Sol. $\Delta Q = mS\Delta T$

$s = \frac{\Delta Q}{m\Delta T}$

$[s] = \left[\frac{ML^2T^{-2}}{MK}\right]$

$[s] = [L^2T^{-2}K^{-1}]$

Statement-(I) is correct

$PV = nRT \Rightarrow R = \frac{PV}{nT}$

$[R] = \frac{[ML^{-1}T^{-2}][L^3]}{[mol][K]}$

$[R] = [ML^2T^{-2}mol^{-1}K^{-1}]$

Statement-II is incorrect

٥٠. A body projected vertically upwards with a certain speed from the top of a tower reaches the ground in t_1. If it is projected vertically downwards from the same point with the same speed, it reaches the ground in t_2. Time required to reach the ground, if it is dropped from the top of the tower, is :

(١) $\sqrt{t_1t_2}$ (٢) $\sqrt{t_1 - t_2}$

(٣) $\sqrt{\frac{t_1}{t_2}}$ (٤) $\sqrt{t_1 + t_2}$

Ans. (١)

Sol. $t_1 □ \frac{u □ \sqrt{u^2 □ 2gh}}{g}$

$t_2 □ \frac{□ u □ \sqrt{u^2 □ 2gh}}{g}$

$t □ \frac{\sqrt{2gh}}{g}$

$t_1 t_2 □ \frac{(u^2 □ 2gh) □ u^2}{g^2} □ \frac{2gh}{g^2} □ t^2$

$□\ t □ \sqrt{t_1 t_2}$

SECTION-B

٥١. In Franck-Hertz experiment، the first dip in the current-voltage graph for hydrogen is observed at ١٠.٢ V. The wavelength of light emitted by hydrogen atom when excited to the first excitation level is __________ nm. (Given hc = ١٢٤٥ eV nm، e = ١.٦ × ١٠ $^{-١٩}$C).

Ans. (١٢٢)

Sol. ١٠.٢ eV = $\frac{hc}{□}$

$□□ \frac{١٢٤٥\ eV □ nm}{١٠.٢ eV}$ = ١٢٢.٠٦ nm

٥٢. For a given series LCR circuit it is found that maximum current is drawn when value of variable capacitance is ٢.٥ nF. If resistance of ٢٠٠□ and ١٠٠ mH inductor is being used in the given circuit. The frequency of ac source is ________ × ١٠^{٣} Hz. (given □^{٢} = ١٠)

Ans. (١٠)

Sol. for maximum current، circuit must be in resonance.

$f_0 □ \frac{١}{٢□\sqrt{L □ C}}$

$f_0 □ \frac{١}{2□\sqrt{١٠٠□١٠^{-٣} □ ٢.٥□١٠^{-٩}}}$

$= \frac{١}{2□\sqrt{٢٥ □ ١٠^{-١١}}}$

$= \frac{١}{2□□5} □ ١٠^{٥} □ \sqrt{١٠}$ Hz

$= \frac{١٠٠}{١٠} □ ١٠^{٣}$ Hz

f_0 = ١٠ × ١٠^{٣} Hz

٥٣. A particle moves in a straight line so that its displacement x at any time t is given by x^{٢} = ١ + t^{٢}. Its acceleration at any time t is x^{-n} where n = ________.

Ans. (٣)

Sol. x^{٢} = ١ + t^{٢}

$٢x \frac{dx}{dt} □ ٢t$

xv = t

$x \frac{dv}{dt} □ v \frac{dx}{dt} □ ١$

x.a + v^{٢} = ١

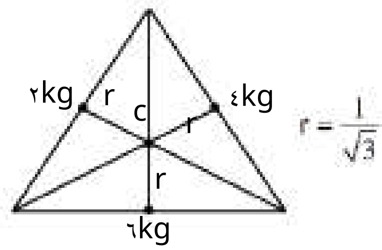
$a = \frac{١ □ v^2}{x} □ \frac{١ □ t^2 / x^2}{x}$

$a = \frac{١}{x^3} □ x^{-٣}$

٥٤. Three balls of masses ٢kg، ٤kg and ٦kg respectively are arranged at centre of the edges of an equilateral triangle of side ٢ m. The moment of inertia of the system about an axis through the centroid and perpendicular to the plane of triangle, will be ________ kg m^{٢}.

Ans. (٤)

Sol.



Moment of inertia about C and perpendicular to the plane is :

I = r^{٢}(٢ + ٤ + ٦)

$= \frac{١}{٣} □ ١٢$

I = ٤ kg-m^{٢}

٥٥. A coil having ١٠٠ turns، area of ٥ × ١٠$^{-٣}$ m^{٢}، carrying current of ١ mA is placed in uniform magnetic field of ٠.٢٠ T such a way that plane of coil is perpendicular to the magnetic field. The work done in turning the coil through ٩٠° is ________ □J.

Ans. (١٠٠)

Sol. W = □U = Uf − Ui

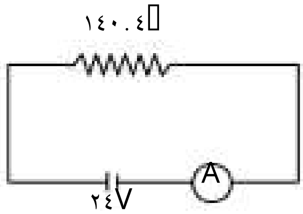
W = (−□.B)$_f$ □ (−□.B)$_i$

= ٠ + (□.B)$_i$

= (١٠٠ × ٥ × ١٠$^{-٣}$ × ١ × ١٠$^{-٣}$) × ٠.٢ J

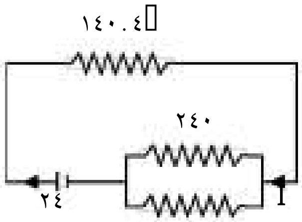
= ١ × ١٠$^{-٤}$ J = ١٠٠ □J

٥٦. In the given figure an ammeter A consists of a ٢٤٠Ω coil connected in parallel to a ١٠ Ω shunt. The reading of the ammeter is ________ mA.



Ans. (١٦٠)

Sol.



$Req = ١٤٠.٤Ω + \frac{٢٤٠ Ω ١٠}{٢٤٠ Ω ١٠}$

$Req = ١٤٠.٤ + \frac{٢٤٠٠}{٢٥٠}$

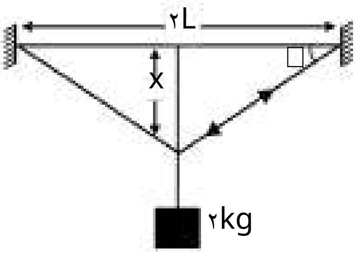
$Req. = ١٥٠Ω$

∴ Current in ammeter $= \frac{٢٤}{١٥٠}$

$= ١٦٠$ mA

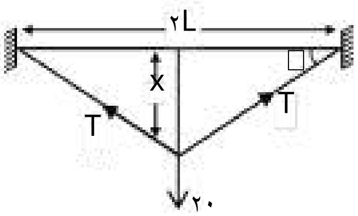
٥٧. A wire of cross sectional area A, modulus of elasticity ٢ × ١٠ ١١ Nm⁻² and length ٢ m is stretched between two vertical rigid supports. When a mass of ٢ kg is suspended at the middle it sags lower from its original position making angle θ = $\frac{١}{١٠٠}$ radian on the points of support. The value of A is ________ × ١٠⁻٤ m² (consider x>>L).

(given : g=١٠ m/s²)



Ans. (١)

Sol.



In vertical derection

٢T sinθ = ٢٠

using small angle approximation sinθ = θ

θ = ___

∴ T = $\frac{١٠}{θ}$

T = ١٠٠٠N

Change in length ΔL $= ٢\sqrt{x^٢ + L^٢} - ٢L$

$= ٢L\left(1 + \frac{x^٢}{٢L^٢} - 1\right)$

$ΔL = \frac{x^٢}{L}$

∴ Modulus of elasticity = $\frac{stress}{strain}$

$٢ \times ١٠^{١١} = \frac{١٠^٣}{A \cdot \frac{x^٢}{L}} \cdot ٢L$

∴ $A = ١ \times ١٠^{-٤}$ m²

٥٨. Two coherent monochromatic light beams of intensities I and ٤I are superimposed. The difference between maximum and minimum possible intensities in the resulting beam is x I. The value of x is________.

Ans. (٨)

Sol. $I_{max} = (\sqrt{٤I} + \sqrt{I})^2 = ٩I$

$I_{min} = (\sqrt{٤I} - \sqrt{I})^2 = I$

∴ Imax – Imin = ٨I

٥٩. Two open organ pipes of length ٦٠ cm and ٩٠ cm resonate at ٦th and ٥th harmonics respectively. The difference of frequencies for the given modes is ________ Hz.

(Velocity of sound in air = ٣٣٣ m/s)

Ans. (٧٤٠)

Sol. The difference in frequency in open organ pipe =

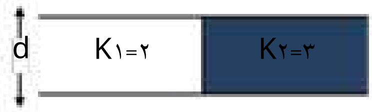
$f = \frac{nv}{٢L}$

$Δf = \frac{٦v}{٢ \times ٠.٦} - \frac{٥v}{٢ \times ٠.٩}$

v = ٣٣٣ m/s

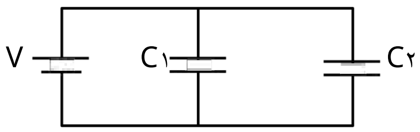
∴ f = ٧٤٠ Hz

٦٠. A capacitor of ١٠ μF capacitance whose plates are separated by ١٠ mm through air and each plate has area ٤ cm² is now filled equally with two dielectric media of $K_١ = ٢$, $K_٢ = ٣$ respectively as shown in figure. If new force between the plates is ٨ N. The supply voltage is ________ V.



NTA Ans. (٨٠)

Sol.



$C_{eq} = C_١ + C_٢$

$C_١ = \frac{٢\varepsilon_0 A}{٢d} = ١٠\ \mu F$

$C_٢ = \frac{٣\varepsilon_0 A}{٢d} = ١٥\ \mu F$

$C_{eq} = ٢٥\ \mu F$

Now the charge on $C_١ = ١٠V\ \mu c$

$C_٢ = ١.٥V\ \mu C$.

Now force between the plates $F = \frac{Q^٢}{٢A\varepsilon_0}$

$\frac{١٠٠V^٢ \times ١٠^{-١٢}}{٢ \times ٢ \times ١٠^{-٤}\varepsilon_0} + \frac{٢٢٥V^٢ \times ١٠^{-١٢}}{2 \times 2 \times 10^{-4} \varepsilon_0} = 8$

$٣٢٥V^٢ = ٨ \times ٤ \times ١٠^{-٤} \times ٨.٨٥$

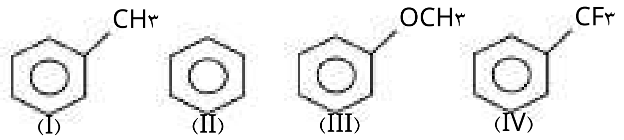
$V^2 = \frac{٣٢ \times ٨.٨٥ \times ١٠^{\text{[illegible]}4}}{٣٢٥}$

$\Rightarrow V = \sqrt{\frac{٢٨٣.٢ \times ١٠^{\text{[illegible]}٤}}{٣٢٥}}$

$\boxed{V = ٠.٩٣ \times ١٠^{\text{[illegible]}٢}}$

CHEMISTRY — TEST PAPER WITH SOLUTION

SECTION-A

٦١. 

The correct arrangement for decreasing order of electrophilic substitution for above compounds

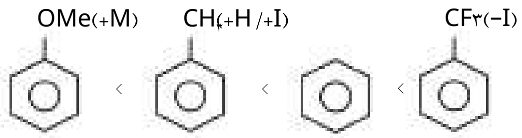
(١) (IV) < (I) < (II) < (III)

(٢) (III) < (I) < (II) < (IV)

(٣) (II) < (IV) < (III) < (I)

(٤) (III) < (IV) < (II) < (I)

Ans. (٢)

Sol. 

٦٢. Molality (m) of ٣ M aqueous solution of NaCl is:
(Given : Density of solution = ١.٢٥ g mL^{-1}, Molar mass in g mol^{-1} : Na-٢٣, Cl-٣٥.٥)

(١) ٢.٩٠ m (٢) ٢.٧٩ m

(٣) ١.٩٠ m (٤) ٣.٨٥ m

Ans. (٢)

Sol. ٣ moles are present in ١ litre solution

$$\text{molality} = \frac{٣ \times ١٠٠٠}{١.٢٥ \times ١٠٠٠ - ٣ \times ٥٨.٥} = ٢.٧٩\ m$$

٦٣. The incorrect statements regarding enzymes are:

(A) Enzymes are biocatalysts.

(B) Enzymes are non-specific and can catalyse different kinds of reactions.

(C) Most Enzymes are globular proteins.

(D) Enzyme – oxidase catalyses the hydrolysis of maltose into glucose.

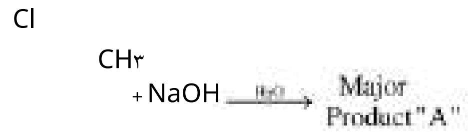
Choose the correct answer from the option given below:

(١) (B) and (C) (٢) (B), (C) and (D)

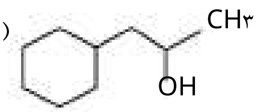
(٣) (B) and (D) (٤) (A), (B) and (C)

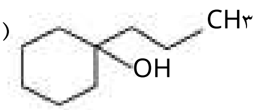
Ans. (٣)

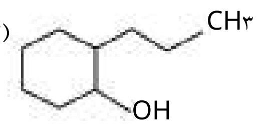
Sol. Direct NCERT Based

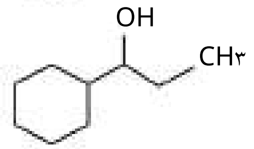
٦٤. 

Consider the above chemical reaction. Product "A" is:

(١) 

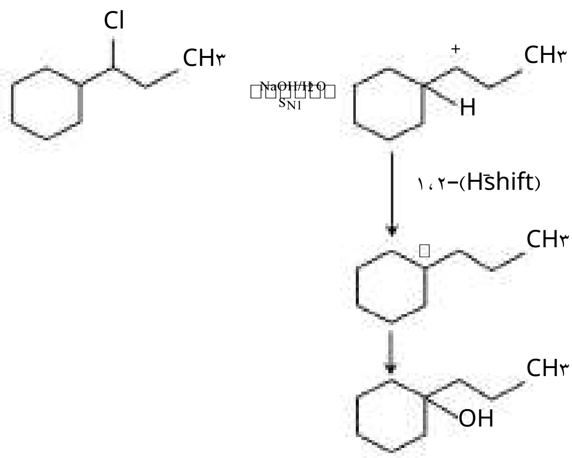
(٢) 

(٣) 

(٤) 

Ans. (٢)

Sol.



(Major Product)

٦٥. During the detection of acidic radical present in a salt, a student gets a pale yellow precipitate soluble with difficulty in NH$_4$OH solution when sodium carbonate extract was first acidified with dil. HNO$_3$ and then AgNO$_3$ solution was added. This indicates presence of:

(١) Br^- (٢) CO_3^{2-}

(٣) I^- (٤) Cl^-

Ans. (١)

Sol. $Ag^+ + I^- \rightarrow AgI$ Yellow ppt.

$Ag^+ + Cl^- \rightarrow AgCl$ White ppt.

$Ag^+ + Br^- \rightarrow AgBr$ Pale yellow ppt

٦٦. How can an electrochemical cell be converted into an electrolytic cell?

(١) Applying an external opposite potential greater than E٠cell

(٢) Reversing the flow of ions in salt bridge.

(٣) Applying an external opposite potential lower than E٠cell.

(٤) Exchanging the electrodes at anode and cathode.

Ans. (١)

Sol. Applied external potential should be greater than E cell in opposite direction.

٦٧. Arrange the following elements in the increasing order of number of unpaired electrons in it.

(A) Sc (B) Cr

(C) V (D) Ti

(E) Mn

Choose the correct answer from the options given below:

(١) (C) < (E) < (B) < (A) < (D)

(٢) (B) < (C) < (D) < (E) < (A)

(٣) (A) < (D) < (C) < (B) < (E)

(٤) (A) < (D) < (C) < (E) < (B)

Ans. (٤)

Sol. Unpaired electron

Sc [Ar] ٤s ٣d

Cr [Ar] ٤s ٣d

V [Ar] ٤s ٣d

Ti : [Ar] ٤s ٣d

Mn : [Ar] ٤s ٣d

٦٨. Match List-I with List-II.

List-I Alkali Metal	List-II Emission Wavelength in nm
(A) Li	(I) ٥٨٩.٢
(B) Na	(II) ٤٥٥.٥
(C) Rb	(III) ٦٧٠.٨
(D) Cs	(IV) ٧٨٠.٠

Choose the correct answer from the options given below:

(١) (A)-(I), (B)-(IV), (C)-(III), (D)-(II)

(٢) (A)-(III), (B)-(I), (C)-(IV), (D)-(II)

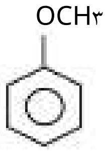
(٣) (A)-(IV), (B)-(II), (C)-(I), (D)-(III)

(٤) (A)-(II), (B)-(IV), (C)-(III), (D)-(I)

Ans. (٢)

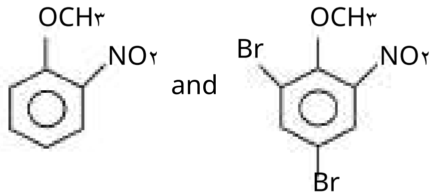
Sol. Fact Based

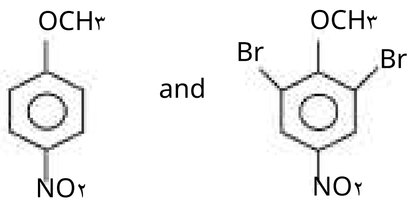
٦٩. The major products formed:

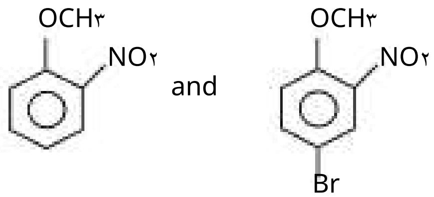


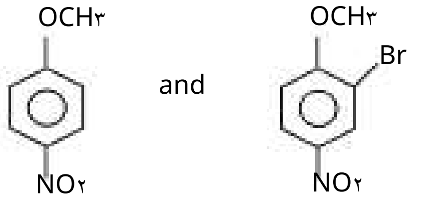
$\xrightarrow{HNO_3, H_2SO_4}$ 'A' $\xrightarrow[Fe]{Br_2 (excess)}$ 'B'

A and B respectively are:

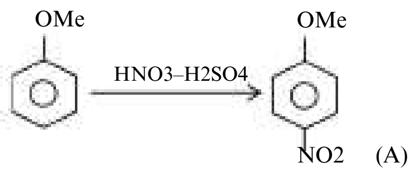
(١)


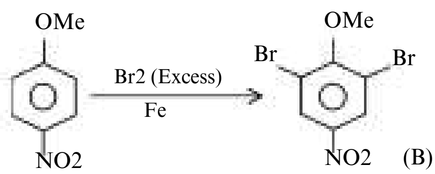
(٢)


(٣)


(٤)


Ans. (٢)

Sol.




٧٠. The incorrect statement regarding the geometrical isomers of ٢-butene is:

(١) cis-٢-butene and trans-٢-butene are not interconvertible at room temperature.

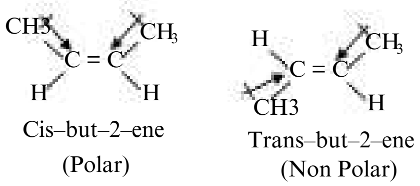
(٢) cis-٢-butene has less dipole moment than trans-٢-butene.

(٣) trans-٢-butene is more stable than cis-٢-butene.

(٤) cis-٢-butene and trans-٢-butene are stereoisomers.

Ans. (٢)

Sol.



Cis-but-٢-ene has higher Dipole moment than trans-but-٢-ene.

٧١. Given below are two statements:

Statement I: PF٥ and BrF٥ both exhibit sp٣d hybridisation.

Statement II: Both SF٦ and [Co(NH٣)٦]٣+ exhibit sp٣d٢ hybridisation.

In the light of the above statements, choose the correct answer from the options given below:

(١) Statement I is true but Statement II is false

(٢) Both Statement I and Statement II are true

(٣) Both Statement I and Statement II are false

(٤) Statement I is false but Statement II is true

Ans. (٣)

Sol.

	Hybridisation		Hybridisation
PF٥	sp٣d	SF٦	sp٣d٢
BrF٥	sp٣d٢	[Co(NH٣)٦]٣+	d٢sp٣

Both Statement (١) and (٢) are false.

٧٢. The number of ions from the following that are expected to behave as oxidising agent is:

Sn٤+, Sn٢+, Pb٢+, Tl٣+, Pb٤+, Tl+

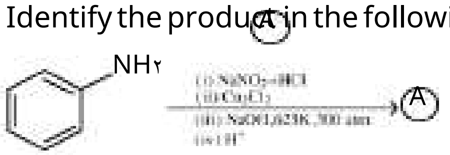
(١) ٣ (٢) ٤

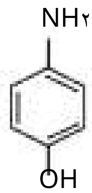
(٣) ١ (٤) ٢

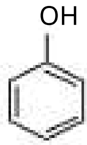
Ans. (٤)

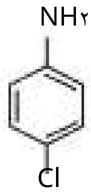
Sol. Due to inert pair effect, Tl٣+ and Pb٤+ can behave as oxidising agents.

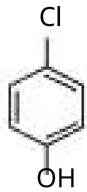
٧٣. Identify the product (A) in the following reaction.



(١)


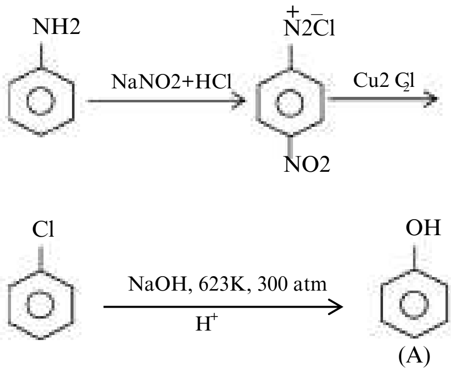
(٢)


(٣)


(٤)


Ans. (٢)

Sol.



٧٤. The correct statements among the following, for a "chromatography" purification method is:

(١) Organic compounds run faster than solvent in the thin layer chromatographic plate.

(٢) Non-polar compounds are retained at top and polar compounds come down in column chromatography.

(٣) Rf of a polar compound is smaller than that of a non-polar compound.

(٤) Rf is an integral value.

Ans. (٣)

Sol. Non polar compounds are having higher value of Rf than polar compound.

٧٥. Evaluate the following statements related to group ١٤ elements for their correctness.

(A) Covalent radius decreases down the group from C to Pb in a regular manner.

(B) Electronegativity decreases from C to Pb down the group gradually.

(C) Maximum covalence of C is ٤ whereas other elements can expand their covalence due to presence of d orbitals.

(D) Heavier elements do not form pπ-pπ bonds. (E) Carbon can exhibit negative oxidation states. Choose the correct answer from the options given below:

(١) (C), (D) and (E) Only (٢) (A) and (B) Only (٣) (A), (B) and (C) Only (٤) (C) and (D) Only

Ans. (١)

Sol. (A) Down the group, radius increases

(B) EN does not decrease gradually from C to Pb.

(C) Correct.

(D) Correct.

(E) Range of oxidation state of carbon ; –٤ to +٤

٧٦. Match List-I with the List-II

List-I Reaction	List-II Type of redox reaction
(A) $N_2(g) + O_2(g) \rightarrow 2NO(g)$	(I) Decomposition
(B) $2Pb(NO_3)_2(s) \rightarrow 2PbO(s) + 4NO_2(g) + O_2(g)$	(II) Displacement
(C) $2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq.) + H_2(g)$	(III) Disproportionation
(D) $2NO_2(g) + 2\overline{O}H(aq.) \rightarrow NO_2^-(aq.) + NO_3^-(aq.) + H_2O(l)$	(IV) Combination

Choose the correct answer from the options given below:

(١) (A)-(I), (B)-(II), (C)-(III), (D)-(IV)

(٢) (A)-(III), (B)-(II), (C)-(I), (D)-(IV)

(٣) (A)-(II), (B)-(III), (C)-(IV), (D)-(I)

(٤) (A)-(IV), (B)-(I), (C)-(II), (D)-(III)

Ans. (٤)

Sol. A → (IV)

B → (I)

C → (II)

D → (III)

٧٧. Consider the given reaction, identify the major product P.

$$CH_3-COOH \xrightarrow[\text{(iv) } H_2O/\overline{O}H,\Delta]{\text{(i) LiAlH}_4 \text{ (ii) PCC (iii) HCN}/\overline{O}H} \text{"P"}$$

(١) $CH_3-CH_2-CH_2-OH$

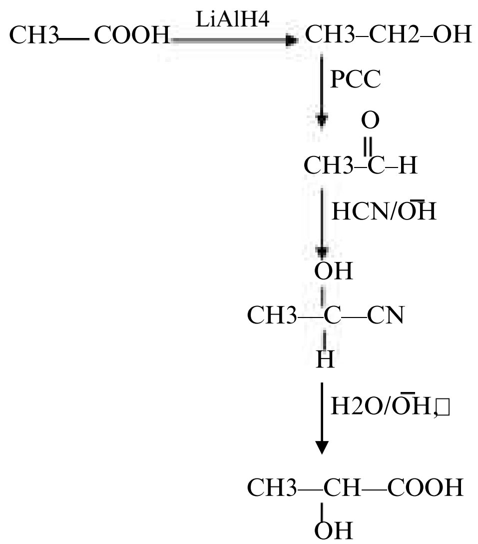
(٢) $CH_3-CH_2-C(=O)-NH_2$

(٣) $CH_3-C(=O)-CH_2CH_3$

(٤) $CH_3-CH(OH)-COOH$

Ans. (٤)

Sol.



٧٨. The correct IUPAC name of $[PtBr_2(PMe_3)_2]$ is:

(١) bis(trimethylphosphine)dibromoplatinum(II)

(٢) bis[bromo(trimethylphosphine)]platinum(II)

(٣) dibromobis(trimethylphosphine)platinum(II)

(٤) dibromodi(trimethylphosphine)platinum(II)

Ans. (٣)

Sol. Dibromo bis(trimethylphosphine) platinum (II)

٧٩. Match List-I with List-II

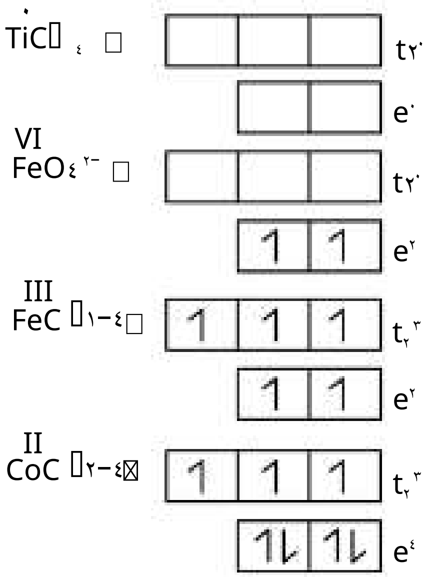
List-I Tetrahedral Complex	List-II Electronic configuration
(A) $TiCl_4$	(I) e^2, t_2^0
(B) $[FeO_4]^{2-}$	(II) e^4, t_2^3
(C) $[FeCl_4]^{-}$	(III) e^0, t_2^0
(D) $[CoCl_4]^{2-}$	(IV) e^2, t_2^3

Choose the correct answer from the option given below:

(١) (A)-(I), (B)-(III), (C)-(IV), (D)-(II)
(٢) (A)-(IV), (B)-(III), (C)-(I), (D)-(II)
(٣) (A)-(III), (B)-(IV), (C)-(II), (D)-(I)
(٤) (A)-(III), (B)-(I), (C)-(IV), (D)-(II)

Ans. (٤)

Sol.



٨٠. The ratio $\frac{K_P}{K_C}$ for the reaction:

$CO(g) + \frac{1}{2}O_{2(g)} \rightleftharpoons CO_2(g)$ is:

(١) $(RT)^{1/2}$ (٢) RT
(٣) ١ (٤) $\frac{1}{\sqrt{RT}}$

Ans. (٤)

Sol. $CO(g) + \frac{1}{2}O_2(g) \to CO_2(g)$

$\Delta n_g = 1 - \left(1 + \frac{1}{2}\right) = -\frac{1}{2}$

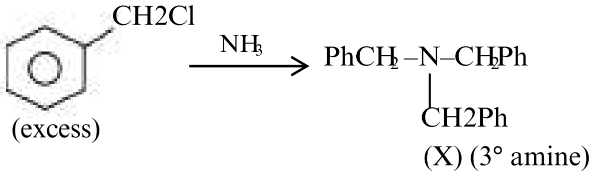
$\frac{K_P}{K_C} = (RT)^{\Delta n_g} = \frac{1}{\sqrt{RT}}$

SECTION-B

٨١. An amine (X) is prepared by ammonolysis of benzyl chloride. On adding p-toluenesulphonyl chloride to it the solution remains clear. Molar mass of the amine (X) formed is________ g mol⁻¹.
(Given molar mass in g mol⁻¹ C : ١٢, H : ١, O : ١٦, N : ١٤)

Ans. (٢٨٧)

Sol.



Molar Mass of (X) is 287 g mol⁻¹

٨٢. Consider the following reactions

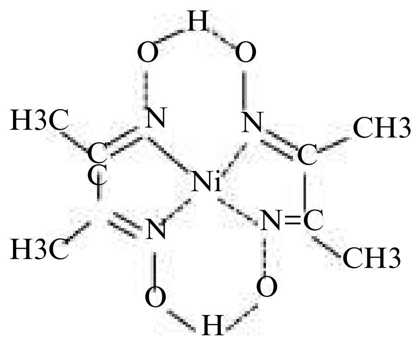
$NiS + HNO_3 + HCl \to A + NO + S + H_2O$

$A + NH_4OH + \begin{matrix} H_3C-C=N-OH \\ | \\ H_3C-C=N-OH \end{matrix} \longrightarrow B + NH_4Cl + H_2O$

The number of protons that do not involve in hydrogen bonding in the product B is________.

Ans. (١٢)

Sol. B ⇒

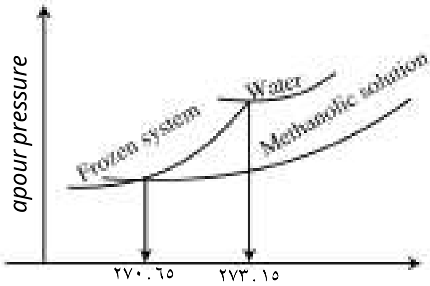


$3NiS + 2HNO_3 + 6HCl \to 3NiCl_2 + 2NO + 3S + 4H_2O$

$NiCl_2 + 2NH_4OH + \begin{matrix} H_3C-C=N-OH \\ | \\ H_3C-C=N-OH \end{matrix}$

$\to NH_4Cl + H_2O + (B)$

٨٣. When 'x' × ١٠⁻³ mL methanol (molar mass = ٣٢ g; density = ٠.٧٩٢ g/cm³) is added to ١٠٠ mL water (density = ١ g/cm³), the following diagram is obtained.



x = ... (nearest integer)

[Given: Molal freezing point depression constant of water at ٢٧٣.١٥ K is ١.٨٦ K kg mol⁻¹]

Ans. (٥٤٣)

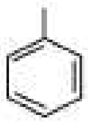
Sol. ΔTf = ٢٧٣.١٥ − ٢٧٠.٦٥ = ٢.٥ K

ΔTf = Kf m ⇒ ٢.٥ = ١.٨٦ × $\frac{n}{٠.١}$

⇒ n = ٠.١٣٤٤ moles

⇒ w = ٠.١٣٤٤ × ٣٢ = ٤.٣ g

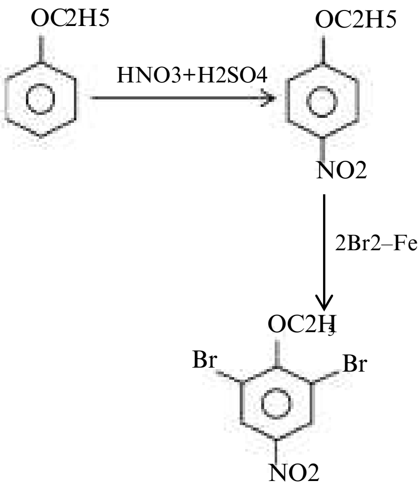
Volume = $\frac{٤.٣}{٠.٧٩٢}$ = ٥.٤٣ ml = ٥٤٣ × ١٠⁻² ml

٨٤.  (i) HNO_3, H_2SO_4 → P (major product) (ii) Br_2 (excess), Fe → Q (major product)

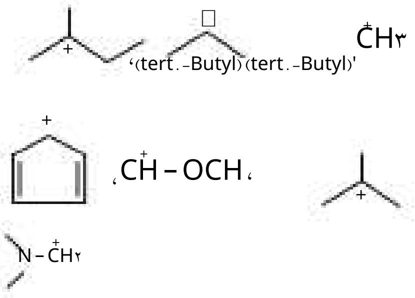
The ratio of number of oxygen atoms to bromine atoms in the product Q is ________ × ١٠⁻¹.

Ans. (١٥)

Sol.

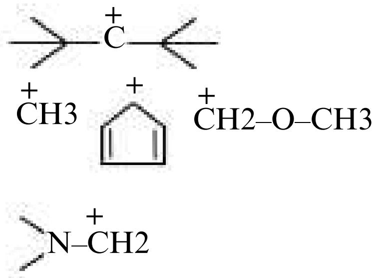


٨٥. Number of carbocation from the following that are not stabilized by hyperconjugation is ... ...



Ans. (٥)

Sol.



٨٦. For the reaction at ٢٩٨ K, ٢A + B → C. ΔH = ٤٠٠ kJ mol⁻¹ and ΔS = ٠.٢ kJ mol⁻¹ K⁻¹. The reaction will become spontaneous above__________

Ans. (٢٠٠٠)

Sol. ΔG = ٠

T = $\frac{\Delta H}{\Delta S}$ ⇒ $\frac{٤٠٠}{٠.٢}$ = ٢٠٠٠ K

٨٧. Total number of species from the following with central atom utilising sp² hybrid orbitals for bonding is ... ...

NH₃, SO₂, SiO₂, BeCl₂, C₂H₂, C₂H₄, BCl₃, HCHO, C₆H₆, BF₃, C₂H₄Cl₂

Ans. (٦)

Sol. Central atom utilising sp² hybrid orbitals

SO₂, C₂H₄, BCl₃, HCHO, C₆H₆, BF₃

٨٨. Consider the two different first order reactions given below $A + B \rightarrow C$ (Reaction ١) $P \rightarrow Q$ (Reaction ٢) The ratio of the half life of Reaction ١ : Reaction ٢ is ٥ : ٢. If t_1 and t_2 represent the time taken to complete $\frac{2}{3}$rd and $\frac{4}{5}$th of Reaction ١ and Reaction ٢, respectively, then the value of the ratio $t_1 : t_2$ is __________ $\times 10^{-1}$ (nearest integer).

[Given: $\log_{10}(3) = 0.477$ and $\log_{10}(5) = 0.699$]

Ans. (١٧)

Sol. $K_1 t_1 = \ln \frac{1}{1-\frac{2}{3}} = \ln 3$

$K_2 t_2 = \ln \frac{1}{1-\frac{4}{5}} = \ln 5$

$\Rightarrow \frac{K_1}{K_2} \times \frac{t_1}{t_2} = \frac{0.477}{0.699}$

$\Rightarrow \frac{t_1}{t_2} = \frac{0.477}{0.699} \times \frac{5}{2} = 1.7 = 17 \times 10^{-1}$

٨٩. For hydrogen atom, energy of an electron in first excited state is -3.4 eV, K.E. of the same electron of hydrogen atom is x eV. Value of x is ______ $\times 10^{-1}$ eV. (Nearest integer)

Ans. (٣٤)

٩٠. Among VO_2^+, MnO_4^- and $Cr_2O_7^{2-}$, the spin-only magnetic moment value of the species with least oxidising ability is ………………. BM (Nearest integer).

(Given atomic member V = ٢٣, Mn = ٢٥, Cr = ٢٤)

Ans. (٠)

Sol. For ٣d transition series,

Oxidising power : $V^{+5} < Cr^{+6} < Mn^{+7}$

V^{+5} : [Ar] $4s^0 3d^0$

Number of unpaired electron = ٠