PART : MATHEMATICS

1. The number of ways to distribute 20 identical chocolates among three students such that each student will get at least one chocolate, is

(1) ${}^{22}C_2$ (2) ${}^{19}C_3$ (3) ${}^{19}C_2$ (4) ${}^{22}C_3$

Ans. **(3)**

Sol. $x_1 + x_2 + x_3 = 20$

let $x_1 = 1 + t_1$, $x_2 = 1 + t_2$, $x_3 = 1 + t_3$

when $t_1, t_2, t_3 \in \{0, 1, 2, ...17\}$

$t_1 + t_2 + t_3 = 17$--------(1)

So number of such distribution is equal to number of non negative integral solutions of equation (1)

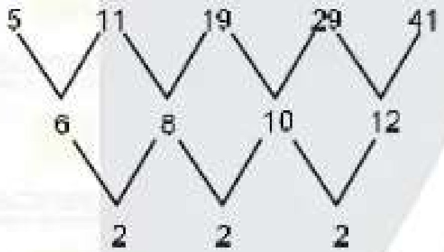
So required solution $= {}^{17+3-1}C_{3-1} = {}^{19}C_2$

2. Sum of first 20 terms of the series : 5 + 11 + 19 + 29 + 41+...........is

(1) 3250 (2) 3520 (3) 3052 (4) 3205

Ans. **(2)**

Sol.



let $Tn + an^2 + bn + c$

$\therefore$ $a + b + c =$ ---------   (1)

$4a + 2b + c = 11$------------(2)

$9a + 3n + v = 19$------------(3)

(2) – (1) $\Rightarrow$ $3a + b = 6$-------(4)

(3) – (2) $\Rightarrow$ $5a + b = 8$ -------(5)

(5) – (4) $\Rightarrow$ $2a = 2 \Rightarrow a = 1$

$\therefore$ $b = 3$ and $c = 1$

$\therefore$ $Tn = n^2 + 3n + 1$

$\therefore$ $S_{20} = \sum_{n=1}^{20} Tn = \sum_{n=1}^{20}\left(n^2 + 3n + 1\right)$

$= \frac{20\times21\times41}{6} + \frac{3\times20521}{2} + 20$

$= 70\times41 + 30\times21 + 20$

$= 10(7\times41+63+2)$

$= 10(287+65)$

$= 10(3521)$

$= 3520$

3. $|x^2-8x+15| - 2x + 7 = 0$, then sum of roots of the equation is

(1) $9+\sqrt{3}$ (2) $6+\sqrt{3}$ (3) $3+\sqrt{3}$ (4) $9-\sqrt{3}$

Ans. **(1)**

Sol.

case I	case II
$x < 3$	$3 \le x \le 5$
$x^2 - 8x + 15 - 2x + 7 = 0$	$x^2 - 8x + 15 + 2x - 7 = 0$
$x^2 - 10x + 22 = 0$	$x^2 - 6x + 8 = 0$
$(x-5)^2 - 3 = 0$	$x = 2, 4$
$x - 5 = +\sqrt{3}$	
$x = 5+\sqrt{3}, 5-\sqrt{3}$	

case III

$5 < x$

$x - 5 = \pm\sqrt{3}$

$x = 5+\sqrt{3}, 5-\sqrt{3}$

sum $= 5+\sqrt{3}+4 = 9+\sqrt{3}$

4. If $\frac{{}^{2n}C_3}{{}^{n}C_3} = \frac{10}{1}$, then value of $\frac{n^2+3n}{n^2-3n+4}$ is equal to

(1) 1 (2) 2 (3) 4 (4) 5

Ans. **(2)**

Sol. $\frac{2n(2n-1)(2n-2)}{n(n-1)(n-2)} = \frac{10}{1}$.

$\frac{4(2n-1)}{n-2} = \frac{10}{1}$

$8n - 4 = 10n - 20 \Rightarrow n = 8$

$\frac{n^2+3n}{n^2-3n+4} = \frac{64+24}{64-24+4} = \frac{88}{44} = 2$

5. $\int \frac{x^2.(x\sec^2 x + \tan x)}{(x\tan x + 1)^2} dx$ is equal to

(1) $\frac{-x^2}{(x\tan x + 1)} + 2\ln|x\sin x - \cos x| + c.$ (2) $\frac{-x^2}{(x\tan x + 1)} - 2\ln|x\sin x + \cos x| + c.$

(3) $\frac{-x^2}{(x\tan x + 1)} + 2\ln|x\sin x + \cos x| + c.$ (4) $\frac{x^2}{(x\tan x + 1)} + 2\ln|x\sin x + \cos x| + c.$

Ans. **(3)**

Sol. Let $I = \int \frac{x^2.(x\sec^2 x + \tan x)}{(x\tan x + 1)^2} dx$

$\because \frac{d}{dx}(x\tan x + 1) = x\sec^2 x + \tan x$

$$\therefore \int \frac{x\sec^2 x + \tan x}{(x\tan x + 1)^2}\,dx = -\frac{1}{x\tan x + 1}$$

$$\therefore I = x^2\left(\frac{-1}{x\tan x + 1}\right) - \int 2x\left(\frac{-1}{x\tan x + 1}\right)dx$$

$$= \frac{-x^2}{(x\tan x + 1)} + 2\int \frac{x\cos x}{x\sin x + \cos x}\,dx$$

$$= \frac{-x^2}{(x\tan x + 1)} + 2\int \frac{\frac{d}{dx}(x\sin x + \cos x)}{x\sin x + \cos x}\,dx$$

$$= \frac{-x^2}{(x\tan x + 1)} + 2\ln|x\sin x + \cos x| + c.$$

6. The coefficient of x^{18}, in the expansion of $\left(x^4 - \frac{1}{x^3}\right)^{15}$, is

(1) ${}^{14}C_7$ (2) ${}^{15}C_8$ (3) ${}^{15}C_6$ (4) ${}^{14}C_9$

Ans. **(3)**

Sol. $T_{r+1} = {}^{15}c_r (x^4)^{15-r}(-\frac{1}{x^3})^r$

$60 - 4r - 3r = 18$

$7r = 42$

$r = 6$

Coff.$= {}^{15}c_6$

7. If $2x^y + 3y^x = 20$, then $\frac{dy}{dx}$ at point (2, 2) is equal to

(1) $\frac{(2-3\ln 2)}{(4-2\ln 2)}$ (2) $\frac{(2+3\ln 2)}{(3+4\ln 2)}$ (3) $\frac{-(2+3\ln 2)}{(3+4\ln 2)}$ (4) $\frac{-(2+3\ln 2)}{(3+2\ln 2)}$

Ans. **(4)**

Sol. Differentiating $2 \cdot x^y\left(\frac{dy}{dx}\ln x + y\frac{1}{x}\right) + 3 \cdot y^x\left(1.\ln y + x\frac{y'}{y}\right) = 0$

Put $x = 2, \quad y = 2$

$$2 \cdot 4\left(\frac{dy}{dx}\ln 2 + 1\right) + 3 \cdot 4\left(\ln 2 + \frac{dy}{dx}\right) = 0$$

$$(2 \cdot \ln 2 + 3)\frac{dy}{dx} + (2 + 3\ln 2) = 0$$

$$\frac{dy}{dx} = -\frac{(2+3\ln 2)}{(3+2\ln 2)}$$

8. Two groups G_1 and G_2 have 15 observations each, means of G_1 and G_2 are 12 and 14 respectively. If variance of G_1 is 14 and combined variance of G_1 and G_2 is 13, then the variance of G_2 is

(1) 12 (2) 10 (3) 11 (4) 13

Ans. (2)

Sol. We know that combined variance of two groups = $\frac{n_1\sigma_1^2 + n_2\sigma_2^2}{n_1+n_2} + \frac{n_1 n_2(\bar{x}_1 - \bar{x}_2)^2}{(n_1+n_2)^2}$

$$\Rightarrow 13 = \frac{15(14)+15(\sigma_2^2)}{30} + \frac{225(4)}{30\times 30}$$

$$\Rightarrow 13 = \frac{14+\sigma_2^2}{2} + \frac{15\times 2}{30}$$

$$\Rightarrow \sigma_2^2 = 10$$

9. In the expansion of $\left(2^{\frac{1}{4}} + \frac{1}{3^{\frac{1}{4}}}\right)^n$, if the ratio of 5[th] term from the beginning and the end is $\sqrt{6}:1$, then the 3[rd] term from the beginning is :

(1) $\frac{60}{\sqrt{3}}$ (2) $30\sqrt{3}$ (3) $90\sqrt{3}$ (4) $60\sqrt{3}$

Ans. (4)

Sol. given $\frac{{}^nC_4\left(2^{\frac{1}{4}}\right)^{n-4}\cdot\left(3^{\frac{-1}{4}}\right)^4}{{}^nC_4\left(3^{\frac{-1}{4}}\right)^{n-4}\cdot\left(2^{\frac{1}{4}}\right)^4} = \sqrt{6}$

$$\Rightarrow 2^{\frac{n-8}{4}}\cdot 3^{\frac{n-8}{4}} = \sqrt{6}$$

$$\Rightarrow 6^{n-8} = 6^2$$

$$\Rightarrow n = 10$$

So $T_3 = {}^{10}C_2\left(2^{\frac{1}{4}}\right)^8\cdot\left(3^{\frac{-1}{4}}\right)^2$

$$= \frac{15\times 3\times 4}{\sqrt{3}} = 60\sqrt{3}$$

10. If the image of point P(1,2,3) in the plane $2x-y+3z=2$ is Q, then the area of triangle PQR is, (where point R is (4, 10, 12))

(1) $\frac{\sqrt{1543}}{4}$ (2) $\frac{\sqrt{2131}}{2}$ (3) $\frac{\sqrt{1531}}{2}$ (4) $\frac{\sqrt{3215}}{4}$

Ans. (3)

Sol. Image of P in plane is Q

$$\frac{x-1}{2} = \frac{y-2}{-1} = \frac{z-3}{3} = -2\,\frac{(2-2+9-2)}{4+1+9}$$

$\vec{PQ} = -2\hat{i} + \hat{j} - 3\hat{k}$, $\vec{PR} = 3\hat{i} + 8\hat{j} + 9\hat{k}$

Area of $\Delta PQR = \frac{1}{2}|\vec{PQ} \times \vec{PR}| = \frac{1}{2}\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ -2 & 1 & -3 \\ 3 & 8 & 9 \end{vmatrix}$

$= \frac{1}{2}\left|\hat{i}(9+24) - \hat{j}(-18+9) + \hat{k}(-16-3)\right|$

$= \frac{1}{2}\sqrt{33^2 + 9^2 + 19^2} = \frac{1}{2}\sqrt{1531}$

11. If $5f(x) + 4f\left(\frac{1}{x}\right) = \frac{1}{x} + 3$ $(x > 0)$, then $18\int_1^2 f(x)dx$ is

(1) $10 \ln 2 + 6$ (2) $10 \ln 2 - 6$ (3) $5 \ln 2 + 16$ (4) $10 \ln 2 - 16$

Ans. **(2)**

Sol. $\because 5f(x) + 4f\left(\frac{1}{x}\right) = \frac{1}{x} + 3$

$5f\left(\frac{1}{x}\right) + 4f(x) = x + 3$

$9f(x) = \frac{5}{x} + 15 - 4x - 12$

$18f(x) = \frac{10}{x} - 8x + 6$

$\int_1^2 18f(x)dx = \left(10\ln x - 4x^2 + 6x\right)_1^2$

$= 10 \ln 2 - 16 + 12 + 4 - 6$

$= 10 \ln 2 - 6$

12. $(P \Rightarrow Q) \wedge (R \Rightarrow Q)$ is equivalent to :

(1) $(P \wedge R) \Rightarrow Q$ (2) $(P \vee R) \Rightarrow Q$

(3) $(P \vee Q) \Rightarrow R$ (4) $(P \wedge Q) \Rightarrow R$

Ans. **(2)**

Sol. $(\sim P \vee Q) \wedge (\sim R \vee Q)$

$\equiv (\sim P \wedge \sim R) \vee Q$

$\equiv \sim (P \vee R) \vee Q$

$\equiv (P \vee R) \Rightarrow Q$

13. If $\bar{a} = 2\hat{i} + 3\hat{j} + 4\hat{k}$, $\bar{b} = \hat{i} - 2\hat{j} - 2\hat{k}$, $\bar{c} = -\hat{i} + 4\hat{j} + 3\hat{k}$ and $\bar{d}$ is a vector perpendicular to both $\bar{b}$ and $\bar{c}$ such that $\bar{a}.\bar{d} - 18$, then $\left|\bar{a} \times \bar{d}\right|^2 =$

(1) 770 (2) 820 (3) 720 (4) 860

Ans. **(3)**

Sol. As $\bar{d}$ is perpendicular to both $\bar{b}$ and $\bar{c}$ $\Rightarrow \bar{d} = \lambda\left(\bar{b} \times \bar{c}\right), \lambda \in R$

$$\bar{d} = \lambda \begin{vmatrix} \hat{i} & \hat{d} & \hat{k} \\ 1 & -2 & -2 \\ -1 & 4 & 3 \end{vmatrix} = \lambda\left(\hat{i}(2) - \hat{j}(1) + \hat{k}(2)\right)$$

$$= \lambda\left(2\hat{i} - \hat{j} + 2\hat{k}\right)$$

$\bar{a}.\bar{d} = 18 \Rightarrow |\lambda| = 2$

$$\left(\bar{a} \times \bar{d}\right)^2 = \lambda^2 \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2 & 3 & 4 \\ 2 & -1 & 2 \end{vmatrix} = 4\left(10\hat{i} + 4\hat{j} - 8\hat{k}\right)^2$$

$= 4\ (100 + 16 + 64) = 4\ (180) = 720$

14. Given that a_1, a_2, a_3 ...., a_n are in A.P with common difference. Then value of

$$\underset{n\to\infty}{\text{Lt}} \sqrt{\frac{d}{n}}\left(\frac{1}{\sqrt{a_1}+\sqrt{a_2}} + \frac{1}{\sqrt{a_2}+\sqrt{a_3}} + \text{-----} + \frac{1}{\sqrt{a_{n-1}}+\sqrt{a_n}}\right) \text{ is}$$

Ans. **(1)**

Sol.
$$\left(\frac{1}{\sqrt{a_1}+\sqrt{a_2}} + \frac{1}{\sqrt{a_2}+\sqrt{a_3}} + \text{-----} + \frac{1}{\sqrt{a_{n-1}}+\sqrt{a_n}}\right)$$

$$= \left(\frac{\sqrt{a_2}-\sqrt{a_1}}{a_2-a_1} + \frac{\sqrt{a_3}-\sqrt{a_2}}{a_3-a_2} + \frac{\sqrt{a_4}-\sqrt{a_3}}{a_4-a_3} + \text{-----} + \frac{\sqrt{a_n}-\sqrt{a_{n-1}}}{a_n-a_{n-1}}\right)$$

$$= \frac{1}{d}\left(\sqrt{a_n} - \sqrt{a_1}\right)$$

$$\therefore \underset{n\to\infty}{\text{Lt}} \sqrt{\frac{d}{n}}\left(\frac{1}{\sqrt{a_1}+\sqrt{a_2}} + \frac{1}{\sqrt{a_2}+\sqrt{a_3}} + \text{-----} + \frac{1}{\sqrt{a_{n-1}}+\sqrt{a_n}}\right)$$

$$= \underset{n\to\infty}{\text{Lt}} \sqrt{\frac{d}{n}}\left(\frac{\sqrt{a_n}-\sqrt{a_1}}{d}\right)$$

$$= \underset{n\to\infty}{\text{Lt}} \left(\frac{\sqrt{a_1+(n-1)d}-\sqrt{a_1}}{\sqrt{n}\sqrt{d}}\right) = \underset{n\to\infty}{\text{Lt}} \left(\sqrt{\frac{a_1}{nd}+\left(1-\frac{1}{n}\right)} - \sqrt{\frac{a_1}{nd}}\right)$$

$= 1$

15. $I = \int_0^{\frac{\pi}{2}} \cos^5 x(\sin^7 x)dx$ is equal to

(1) $\frac{1}{120}$ (2) $\frac{1}{60}$ (3) $\frac{1}{240}$ (4) $\frac{\pi}{120}$

Sol. By wall's formulas

$$I = \frac{(4\times2)(6\times4\times2)}{12\times10\times8\times6\times4\times2} = \frac{1}{120}$$

16. Let A be a 2×2 matrix with $A^2 = I$ and all entries of A are non-zero. If sum of leading diagonal elements is 'a' and det(A) = b, then the value of $(3a^2 + b^2)$ is

Ans. 1

Sol. $|A|^2 = 1 \Rightarrow b^2 = 1$

Let $A = \begin{bmatrix} a_1 & b_1 \\ a_2 & b_2 \end{bmatrix}$

$$A^2 = \begin{bmatrix} a_1 & b_1 \\ a_2 & b_2 \end{bmatrix}\begin{bmatrix} a_1 & b_1 \\ a_2 & b_2 \end{bmatrix} = \begin{bmatrix} a_1^2 + b_1a_2 & a_1b_1 + b_1b_2 \\ a_1a_2 + b_2a_2 & a_2b_1 + b_2^2 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$$

$\Rightarrow$ $a_2(a_1 + b_2) = 0$ and $b_1(a_1 + b_2) = 0$

$\Rightarrow$ $a_1 + b_2 = 0$

$\Rightarrow$ Tr (A) = 0

$\Rightarrow$ a = 0

So $(3a^2 + b^2) = 0 + 1 = 1$

17. A pair of dice is rolled 5 times. If getting a sum 5 is considered as a success, then the probability of four successes is

(1) $\frac{4}{9^5}$ (2) $\frac{20}{9^4}$ (3) $\frac{5}{9^4}$ (4) $\frac{40}{9^5}$

Ans. (4)

Sol. S = {(1, 1), (1, 2),................ (1, 6)

(2, 1), (2, 2),....................... (2, 6)

(6, 1), (6, 2),.........................(6, 6)}

Event of success = {(1, 4), (4, 1), (2, 3), (3, 2)}

$p = \frac{4}{36}$

Probability of exactly four successes is = ${}^5C_4\left(\frac{8}{9}\right)^1\left(\frac{1}{9}\right)^7$

18. If f(x) = [a + 13 sinx], where x ∈ (0, π) and [•] denotes G.I.F. and a ∈ I, then the number of points of non-differentiability is

(1) 24 (2) 26 (3) 25 (4) 23

Ans. (3)

Sol. f(x) = a + [13 sinx] ∵ a ∈ I and x ∈ (0, π)

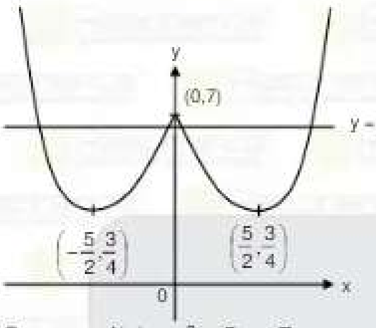
∵ total number of points of non-differentiability of [p sinx] = 2p – 1 here p = 13

∴ total number of points of non-differentiability of [13 sinx] = 25

19. If the equation $|x^2 - 5|x| + 7| = P$, $P \in I$, has 4 solutions, then the number of possible values of P is.

Ans. **(6)**

Sol. Let $y = ||x|^2 - 5|x| + 7|$ $\because x^2 = |x|^2$ as $x \in R$



Suppose $f(x) = x^2 - 5x + 7$

So $y = |f(|x|)|$

for 4 solutions

$\frac{3}{4} < P < 7$

But $P \in I$ so $P = 1, 2, 3, 4, 5, 6$

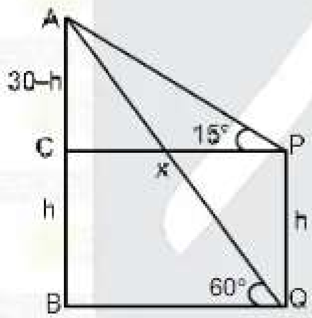
6 values

20. AB is a building of height 30 m with base B. PQ is a pole with base Q. Angle of depression from point A to P and Q are 15° and 60° respectively. A point C is on the same level of point P, on the building. Then area of rectangle PCBQ is

(1) $60(\sqrt{3}-1)$ (2) $600(\sqrt{3}+1)$ (3) $600(\sqrt{3}-1)$ (4) $60(\sqrt{3}+1)$

Ans. **(3)**

Sol.



$\tan 15° = \frac{30-h}{x}$

$\tan 60° = \frac{30}{x} \Rightarrow x = \frac{30}{\sqrt{3}}$

$\frac{2-\sqrt{3}}{\sqrt{3}} = \frac{30-h}{30} \Rightarrow 30\left(\frac{2-\sqrt{3}}{\sqrt{3}}\right) = 30 - h$

$h = 30 - 30 \times \frac{2}{\sqrt{3}} + 30 = 60 - \frac{60}{\sqrt{3}}$

$\text{Area} = \frac{30(60)(\sqrt{3}-1)}{3} = 600(\sqrt{3}-1)$

21. Number of words with or without meaning using all the letters of the word ASSASSINATION such that all the vowels come together is :

(1) 38004 (2) 38042 (3) 50400 (4) 60200

Ans. (3)

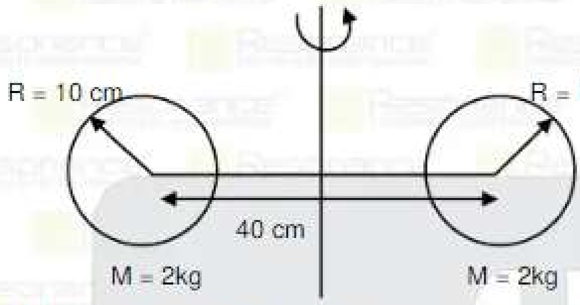
Sol. We have to arrange bundle of AAAIIO with seven consonants SSSSNTN :

So. no of words $= \frac{8!}{4!2!} \times \frac{6!}{3!2!1!}$

$= 50400$

PART : PHYSICS

1.



Moment of inertia of system of two solid spheres connected by light rod about given axis is $n \times 10^{-3}$ kg m^2, then n will be :

(1) 180 (2) 176 (3) 166 (4) 156

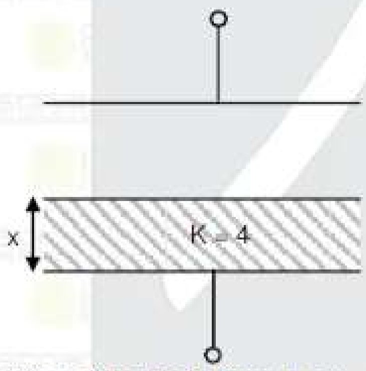
Ans. **(2)**

Sol. $I = 2\left[\frac{2}{5}mR^2 + md^2\right]$

d = 20 cm = 2R

$I = 2\left[\frac{2}{5}mR^2 + 4mR^2\right] = \frac{44}{5}MR^2 = 176 \times 10^{-3}$ kg.m^2

2.



When dielectric is filled upto x = d/3 capacitance is $C_1 = 2\mu F$ and when dielectric is filled up to x = 2d/3 capacitance is C_2 then C_2 will be :

(1) 12 μF (2) 9 μF (3) 6 μF (4) 3 μF

Ans. **(4)**

Sol. $C_1 = \frac{\varepsilon_0 A}{\frac{d}{3k} + \frac{2d}{3}} = \frac{\varepsilon_0 A}{\frac{d}{12} + \frac{2d}{3}} = \frac{\varepsilon_0 A}{\frac{d}{12}(1+8)} = \frac{12\varepsilon_0 A}{9d} = \frac{4\varepsilon_0 A}{3d}$

$C_2 = \frac{\varepsilon_0 A}{\frac{2d}{3k} + \frac{d}{3}} = \frac{\varepsilon_0 A}{\frac{2d}{12} + \frac{d}{3}} = \frac{\varepsilon_0 A}{\frac{d}{6}(1+2)} = \frac{6\varepsilon_0 A}{3d} = \frac{2\varepsilon_0 A}{d}$

$\frac{C_1}{C_2} = \frac{4/3}{2/1}$; $\frac{C_1}{C_2} = \frac{4}{2\times 3} = \frac{2}{3}$; $C_2 = \frac{3}{2}C_1$

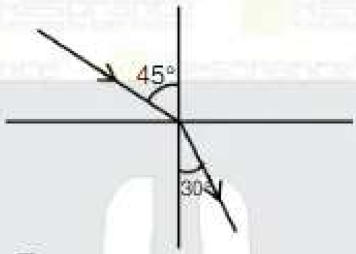
$C_2 = 3\mu F$

3. In an Electromagnetic wave $E = E_0\sin(\omega t - kx)$, $B = B_0\sin(\omega t - kx)$. The ratio of average energy density of electric field and average energy density of magnetic field will be

(1) 2/1 (2) 1/1 (3) 1/2 (4) 4/1

Ans. **(2)**

4. The angle of incidence of a ray in a medium is 45° and angle of refraction in the second medium is 30° let λ_1, f_1 and λ_2, f_2 be the wavelength & frequency in the two media.



(1) $\lambda_1 = \sqrt{2}\ \lambda_2, f_1 = f_2$ (2) $\lambda_2 = \sqrt{2}\ \lambda_1, f_1 = f_2$ (3) $\lambda_1 = \lambda_2, f_1 = \sqrt{2}\ f_2$ (4) $\lambda_1 = \lambda_2, f_2 = \sqrt{2}\ f_1$

Ans. **(1)**

Sol. $n_1\sin45° = n_2\sin30°$

$$\frac{C}{V_1}\times\frac{1}{\sqrt{2}} = \frac{C}{V_2}\times\frac{1}{2} \Rightarrow V_1 = \sqrt{2}V_2,\ \lambda_1 = \sqrt{2}\lambda_2$$

5. If the height of transmitting Antenna on the earth surface is increase by 21%, by what percentage will the range of the signals on the surface increase :

(1) 42% (2) 40% (3) 20% (4) 10%

Ans. **(4)**

Sol. $d = \sqrt{2RH}$

$d' = \sqrt{2R\times1.21H}$

$$\frac{d'-d}{d}\times100 = 10\%$$

6. Find the radius of electrons in 5^{th} orbit of Li^{++}

(1) 3.3Å (2) 7.8Å (3) 4.4Å (4) 5.7Å

Ans. **(2)**

Sol. $r = \frac{n^2}{Z}a_0 = \frac{5^2}{3}\times5.3\times10^{-11}m \approx 4.4Å$

7. A wire is extended by 20% and area of cross-section is reduce by 4%. Find the percentage change in resistance of wire :

(1) 25% (2) 30% (3) 40% (4) 20%

Ans. **(1)**

Sol. Suppose initial length of wire = l

cross area sectional = A

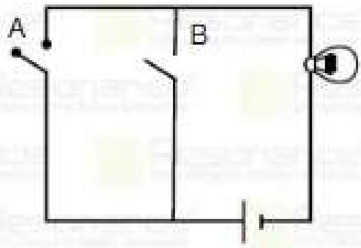
And resistivity of material = ρ

$\therefore$ Initial resistance $R = \rho \times \ell/A$

Now Resistance of change $R' = \frac{\rho\cdot[1+0.20]\ell}{A[1-0.04]}$

$R' = 1.25\frac{\rho\ell}{A} = 1.25R$ $\therefore$ % change $\frac{\Delta R}{R}\times100 = 25\%$

8. Find the type of logic gate



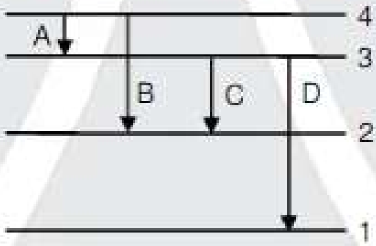
(1) NOR (2) AND (3) NAND (4) OR

Ans. **(4)**

Sol. OR

A	B	Output
1	1	1
1	0	1
0	1	1
0	0	0

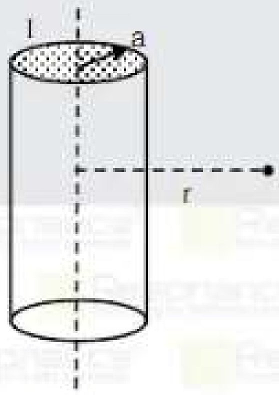
9. Which of the transitions will give maximum wavelength of emitted photon :



(1) A (2) B (3) C (4) D

Ans. **(1)**

10. Solid conductor of radius a carrying uniformly distributed current. Select the correct option about magnetic field B at radial distance r.



(1) if $r < a$, $B \propto r$ if $r > a$, $B \propto 1/r^2$

(2) if $r < a$, $B \propto r$ if $r > a$, $B \propto r^2$

(3) B is uniformly distributed for $r < a$ and for $r > a$, $B \propto 1/r$

(4) if $r < a$ B is proportional to r and for $r > a$, $B \propto 1/r$

Ans. **(4)**

Sol. For $r < a$

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

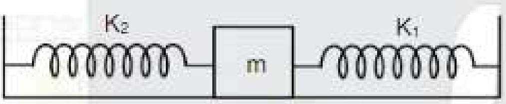
$\therefore B \propto r$

for $r > a$

$$B = \frac{\mu_0 I}{2\pi r}$$

$\therefore B \propto \frac{1}{r}$

11.



Time period of oscillations of this system is

(1) $T = 2\pi\sqrt{\frac{m}{k_1 + k_2}}$ (2) $T = 2\pi\sqrt{\frac{m(k_1 + k_2)}{k_1 k_2}}$ (3) $T = 2\pi\sqrt{\frac{k_1 + k_2}{m}}$ (4) $T = 2\pi\sqrt{\frac{k_1 k_2}{(k_1 + k_2)m}}$

Ans. **(1)**

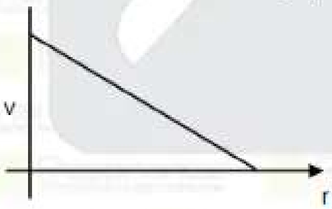
12. Kinetic energy of electron, proton and α–particle is given as 4K, K and 2K respectively. Correct order of de–Broglie wavelength λ_e, λ_p, λ_α for electron, proton and α– particle respectively is:

(1) $\lambda_e > \lambda_\alpha > \lambda_p$ (2) $\lambda_e = \lambda_p > \lambda_\alpha$ (3) $\lambda_e > \lambda_p > \lambda_\alpha$ (4) $\lambda_\alpha > \lambda_p > \lambda_e$

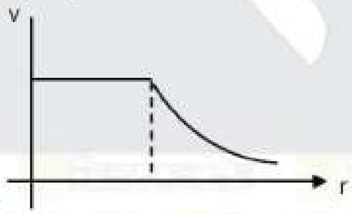
Ans. **(3)**

Sol. $\lambda_e = \frac{h}{\sqrt{2m_e 4K}}$; $\lambda_p = \frac{h}{\sqrt{2m_p K}} < \lambda_e$; $\lambda_\alpha = \frac{h}{\sqrt{2(4m_p)2K}} = \frac{\lambda_p}{2\sqrt{2}}$

13. Potential and radial distance graph for uniformly charged spherical shell will be :



(1)



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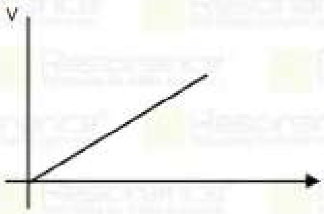

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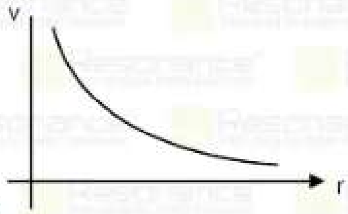


(4)

Ans. **(2)**

14. A block of mass 100 gram attached to spring rotating with angular velocity 5 rad/s in horizontal plane radius of circular path of block is 20mm and spring constant is k = 7.5 N/m then tension in spring will be:

(1) 0.01 N (2) 0.05 N (3) 1 N (4) 2.5 N

Sol. $T = m\omega^2 r$

$= 0.1(5)^2(20 \times 10^{-3})$

$= 50 \times 10^{-3}$

$= 0.05$ N

15. EMF will induced if

(a) Coil moves in uniform magnetic field with constant velocity

(b) Coil moves in non-uniform magnetic field with constant velocity

(c) Coil rotating in uniform magnetic field

(d) Area of coil increase in uniform magnetic field

then which of following is correct :

(1) a & b (2) b & c (3) c & d (4) b & d

Ans. **(4)**

16. **Assertion (A) :** There is atmosphere on the surface of earth and no atmosphere on the surface of moon.
Reason (R) : Escape velocity from the surface of earth is more than escape velocity from the surface of moon. Gases get escape out from moon due to its escape speed load than root mean square velocity at the moon.

(1) Both A and R are correct but R is not the correct explanation of A

(2) A is correct but R is not correct

(3) A is not correct but R is correct

(4) Both A and R are correct and R is the correct explanation of A

Ans. **(1)**

17. A planet has mass twice of that of earth but same density as that of earth. Weight of an object placed on earth is 'W' then what will be the weight of the same object on this planet

(1) $W \times 2$ (2) $W \times 2^{4/3}$ (3) $W \times 2^{1/3}$ (4) $W \times 2^{5/3}$

Ans. **(3)**

Sol. Weight $W_e = mg = \frac{mGM}{R^2}$

$$\frac{M}{\frac{4\pi}{3}R_e^3} = \frac{2M}{\frac{4\pi}{3}R_p^3}$$

$$R_p = R_e\, 2^{\frac{1}{3}}$$

Ratio of weight $\Rightarrow \frac{We}{Wp} = \frac{Me}{Mp} \times \left(\frac{R_p}{R_e}\right)^2$

$$\frac{W}{W_p} = \frac{M}{2M} \times (2^{1/3})^2 \Rightarrow \frac{W}{W_p} = 2^{\frac{2}{3}-1} \Rightarrow W_p = W \times 2^{\frac{1}{3}}$$

18. In a process Rate at which work done by gas is 10J/s and rate of heat supply to gas is 30J/s. Determine the rate at which internal energy of gas is increasing (in J/s)

(1) 20 (2) 30 (3) 40 (4) 60

Ans. (1)

Sol. First law of thermodynamic

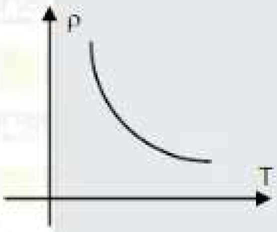
$Q = \Delta u + w$

$\dot{Q} = \frac{du}{dt} + \dot{W}$

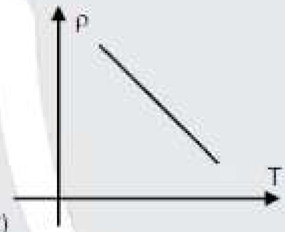
$30 = \frac{du}{dt} + 10$

$\frac{du}{dt} = 20$ J/s

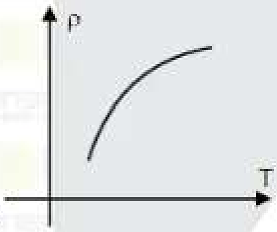
19. Select the correct graph which give variation of resistivity of semiconductor with increase in temperature.



(1)



(2)



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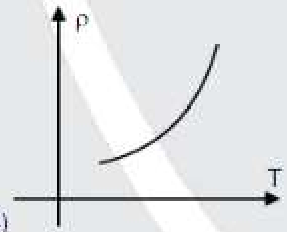


(4)

Ans. **(1)**

20. Two resistance $R_1 = [15 \pm 0.5]\Omega$ and $R_2 = (10 \pm 0.5)\Omega$ are connected in parallel. The equivalent resistance will be :

(1) $[6 \pm 0.26]\ \Omega$ (2) $[6 \pm 0.52]\Omega$ (3) $[6 \pm 0.14]\Omega$ (4) $[6 \pm 0.75]\Omega$

Ans. **(1)**

Sol. $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$

$\frac{1}{R} = \frac{1}{15} + \frac{1}{10}$

$R = 6\Omega$

$\frac{\Delta R}{R^2} = \left[\frac{\Delta R_1}{R_1^2} + \frac{\Delta R_2}{R_2^2}\right]$

$\Delta R = R^2\left[\frac{\Delta R_1}{R_1^2} + \frac{\Delta R_2}{R_2^2}\right] = 6^2\left[\frac{0.5}{15^2} + \frac{0.5}{10^2}\right] = 36\ [0.0022 + 0.005]$

$= 36\ [0.0072] = 0.2592 \approx 0.26\ \Omega$

Resistance is $R \pm \Delta R = 6 \pm 0.26$

PART : CHEMISTRY

1. If the radius of hydrogen atom is 51 pm then what will be the radius of 5[th] orbit of Li^{2+} (in pm) ?
(Report your answer to the nearest integer).

Ans. **(425)**

Sol. $r_H = 51$ pm

$$r_{Li^{+2}} = \frac{r_H \times n^2}{Z} = \frac{51 \times 5^2}{3} = 17 \times 25 = 425 \text{ pm}$$

2. If X forms CCP and Y occupy $\frac{1}{3}$ of octahedral voids then what will be the formula of the compound ?

(1) XY_3 (2) X_2Y_3 (3) X_3Y (4) X_3Y_2

Ans. **(3)**

Sol. Number of X atom = 4

Number of Y atom = $4 \times \frac{1}{3} = \frac{4}{3}$

Formula of compound $(X_4Y_{4/3}) \times \frac{3}{4} = X_3Y$

3. What is the Oxidation state of Mo in ammonium phosphomolybdate ?

Ans. **(6)**

Sol. the Oxidation state of Mo in ammonium phosphomolybdate = + 6

$(NH_4)_3PO_4.12MoO_3$

4. Find log K_{eq} value for a reaction for which $\Delta H^o = -54.07$ KJ/mol and $\Delta S^o = 10$ J/K at T = 293K
Given : 2.303 RT = 5610 (Report your answer in to nearest integer)

Ans. 10

Sol. $\Delta G^o = \Delta H^o - T\Delta S^o$

$\Delta G^o = -54070 - 293 \times 10 = -57000$ J

$\Delta G^o = -2.303$ RT log K_{eq}

-57000 J $= -5610$ log K_{eq}

log $K_{eq} = 10.16 = 10$

5. Match the following

	List-I (species)		List-II (type of bond)
(A)	NO_2	(P)	N – N
(B)	N_2O	(Q)	N = O
(C)	N_2O_4	(R)	N – O – N
(D)	N_2O_5	(S)	N = O / N = N

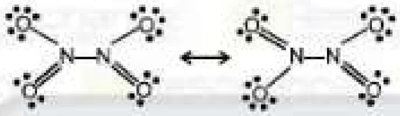
	(A)	(B)	(C)	(D)
(1)	Q	S	P	R
(2)	P	R	Q	S
(3)	Q	S	R	P
(4)	S	P	Q	R

Ans. **(1)**

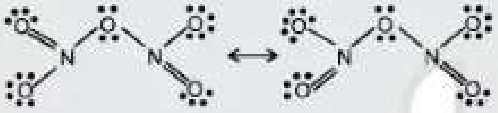
Sol. NO_2

N_2O

N_2O_4



N_2O_5

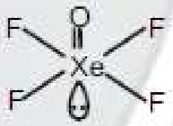


6. Which of the following have square pyramidal structure :

(1) $XeOF_4$ (2) BrF_3 (3) XeF_4 (4) XeO_3

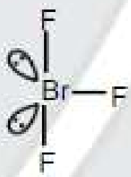
Ans. **(1)**

Sol. (1) $XeOF_4$



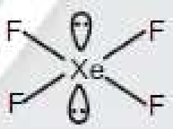
(Square pyramidal)

(2) BrF_3



(T-shape)

(3) XeF_4



(Square planner)

(4) XeO_3

(Pyramidal)

7. For a reversible reaction

$A_2B_3\ (g) \rightleftharpoons 2A\ (g) + 3B\ (g)$ the initial concentration of A_2B_3 is C mol/L and equilibrium constant of the reaction is K, then degree of dissociation (α) is :

(1) $\alpha = \left[\frac{K}{108\ C^4}\right]^{1/5}$ (2) $\alpha = \left[\frac{108\ C^4}{K}\right]^{1/5}$

(3) $\alpha = \left[\frac{K}{27\ C^4}\right]^{1/5}$ (4) $\alpha = \left[\frac{4\ C^2}{K}\right]^{1/3}$

Ans. **(1)**

Sol.

	A_2B_3	$\rightleftharpoons$	2A	+	3B
Initial conc.	C		0		0
	$C - C\alpha$		$2C\alpha$		$3C\alpha$

$$K = \frac{(2C\alpha)^2(3C\alpha)^3}{(C - C\alpha)}$$

$$K = \frac{108C^5\alpha^5}{C} = 108C^4\alpha^5$$

$$\alpha = \left[\frac{K}{108C^4}\right]^{1/5}$$

8. Total number of ambidentate ligand in the complex $[Co(en)(SCN)_4]^{-1}$ is

Ans. **(4)**

Sol. SCN^- is an ambidentate ligand.

9. Amongst the following select the best oxidising & reducing agent respectively :

(1) Ce^{+4}, Tb^{+2} (2) Ce^{+3}, Eu^{+2} (3) Ce^{+4}, Eu^{+2} (4) Tb^{+2}, Eu^{+2}

Ans. **(3)**

Sol. $(E^0_{Ce^{+4}/Ce^{+3}})_{RP} = 1.74\ V$

Eu^{+2} is a strong reducing agent changing to common oxidation state + 3.

10. **Assertion** : Magnetic moment of $[Fe(H_2O)_6]^{+3}$ is 5.92 BM and that of $[Fe(CN)_6]^{-3}$ is 1.73 BM

Reason : Oxidation state of Fe in both the complexes is +3

(1) Both **Assertion** and **Reason** are correct and **Reason** is the correct explanation of **Assertion**.

(2) Both **Assertion** and **Reason** are not correct and **Reason** is the correct explanation of **Assertion**.

(3) **Reason** is correct and **Assertion** is not correct

(4) **Assertion** is correct and **Reason** is not correct

Ans. **(2)**

Sol. In $[Fe(H_2O)_6]^{+3}$, H_2O is a weak field ligend so configuration of Fe^{+3} is $t_{2g}^{1,1,1}$, $e_g^{1,1}$

so number of unpaired electron are 5 and magenetic momentum is 5.92 BM

In $[Fe(CN)_6]^{-3}$, CN^- is a weak field ligend so configuration of Fe^{+3} is $t_{2g}^{2,2,1}$, $e_g^{0,0}$

so number of unpaired electron are 1 and magenetic momentum is 1.73 BM

11. Which substance is added in cement for increase in setting time of cement

(1) silica (2) clay (3) gypsum (4) lime stone

Ans. **(3)**

Sol. The purpose of adding gypsum is only to slow down the process of setting of the cement so that it gets sufficiently hardened.

12. For which of the following pair of elements have maximum difference in value of electron gain enthalpy (ΔHeg)

(1) Ne, Cl (2) Ar, F (3) Ar, Cl (4) Ne, F

Ans. **(1)**

Sol. Cl has maximum –ve ΔHeg and Ne has most +ive ΔHeg hence difference will be maximum for Ne and Cl.

Element	ΔHeg (KJ/mole)
F	–333
Cl	–349
Ne	+48
Ar	+116

13. When 5 mole of $BaCl_2$ mixed with 2 mole of Na_3PO_4 then Maximum Number of mole of $Ba_3(PO_4)_2$ are formed.

Ans. **1.00**

Sol. $3BaCl_2 + 2Na_3PO_4 \longrightarrow Ba_3(PO_4)_2 + 6NaCl$

inicial mole 5 2

L.R. $\frac{5}{3} = 1.67$ $\frac{2}{2} = 1$ (L.R. = Na_3PO_4)

$$\frac{\text{mole}\,Na_3PO_4}{2} = \frac{\text{mole}\,Ba_3(PO_4)_2}{1}$$

maximum number of mole of $Ba_3(PO_4)_2 = \frac{2}{2} = 1$ mole

14. $2Na[Ag(CN)_2]_{aq} + Zn(s) \longrightarrow Na_2[Zn(CN)_4]_{aq} + 2Ag(s)$ the given reaction is an example of

(I) Redox reaction
(II) Displacement reaction
(III) Combination reaction
(IV) Decomposition reaction

correct answer is

(1) I, II (2) I, III (3) I, IV (4) II, IV

Ans. **(1)**

Sol. Theory based

15. Standard electrode potential M^{2+}/M does not depends upon :

(1) Sublimation enthalpy (2) Hydration enthalpy
(3) Ionisation enthalpy (4) Concentration of metal ion

Ans. **(4)**

Sol. Theory based

16. Polymer which is named as orlon is

(1) Polyamide (2) Polyacrylonitrile
(3) Polycarbonate (4) Polythene

Ans. **(2)**

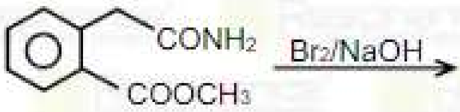
Sol. $CH_2{=}CH(CN) \longrightarrow \left(-CH_2-CH(CN)-\right)_n$

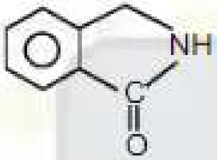
17. Photochemical smog occurs in which area?

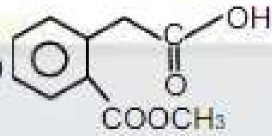
(1) Himalaya village area (2) Industrial area

(3) Plain area (4) Muddy area

Ans. **(2)**

18.  Product is

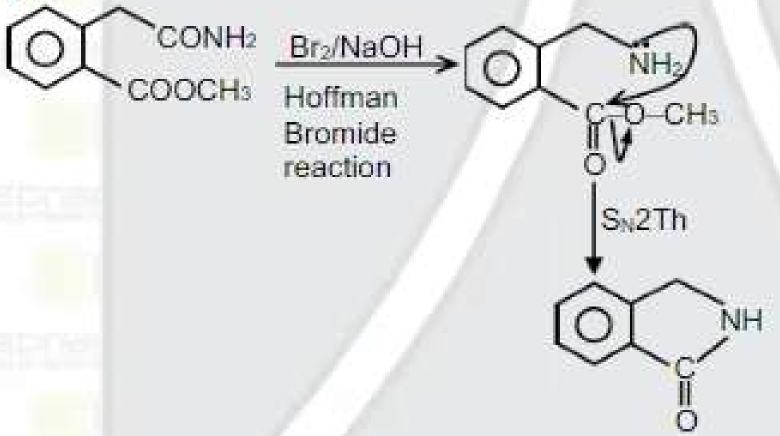
(1) 

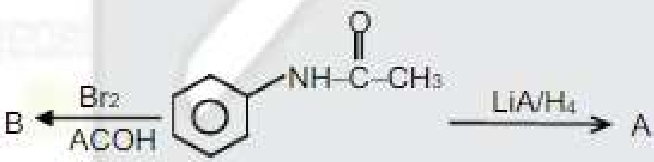
(2) 

(3) 

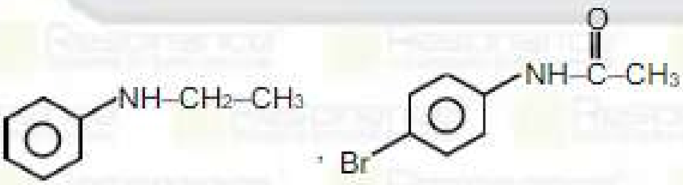
(4) 

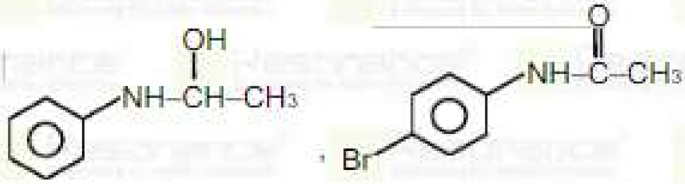
Ans. **(1)**

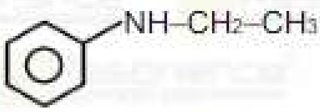
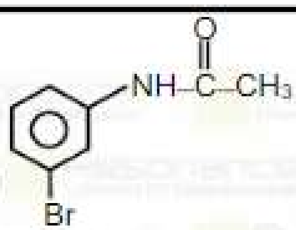
Sol. 

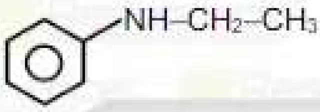
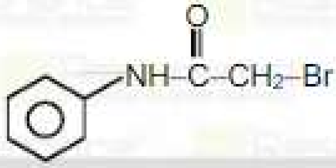
19. 

Identify A and B

(1) 

(2) 

(3)  , 

(4)  , 

Ans. **(1)**

20. Match the following :

	List-I (Element)		List-II (Reagent use to identify)
(A)	Halogen	(I)	$Fe(CN)_6$
(B)	Sulphur	(II)	$AgNO_3$
(C)	Nitrogen	(III)	$[Fe(CN)_5NO]^{-2}$
(D)	Phosphorous	(IV)	$(NH_4)_2MoO_4$

(1) A – II ; B – III ; C – I ; D – IV
(2) A – III ; B – I ; C – II ; D – IV
(3) A – I ; B – II ; C – III ; D – IV
(4) A – II ; B – I ; C – IV ; D – III

Ans. **(1)**

Sol. (1) Halogen + $AgNO_3 \rightarrow$ AgX ppt
(2) 'S' + Sodium nitro prusside $\rightarrow$ Violet colour
(3) 'N' + $[Fe(CN)_6]^{4-}$ $\rightarrow$ Blue colour
(4) 'P' + $(NH_4)_2$ $MoO_4 \rightarrow (NH_4)_3$ $PO_4.12MoO_3 \rightarrow$Yellow colour

21. Match the following :

	List-I		List-II
(A)	Vitamin A	(I)	Beri-Beri
(B)	Thiamine	(II)	Scurvery
(C)	Ascorbic acid	(III)	Chelosis
(D)	Riboflavin	(IV)	Xeropthalmia

(1) A – IV ; B – I ; C – II ; D – III
(2) A – I ; B – II ; C – III ; D – IV
(3) A – III ; B – IV ; C – II ; D – I
(4) A – II ; B – I ; C – III ; D – IV

Ans. **(1)**

Sol. Vitamin A $\rightarrow$ Xeropthalmia
Thiamine $\rightarrow$ Beri-Beri
Ascorbic acid $\rightarrow$ Chelosis
Riboflavin $\rightarrow$ Xeropthalmia

22. Match the following :

	List-I		List-II
(A)	Etard	(I)	CO + HCl
(B)	Gatterman-koach	(II)	$CrO_2Cl_2 + CS_2$
(C)	H.V.Z.	(III)	Red P + X_2
(D)	Haloform reaction	(IV)	I_2/NaOH

(1) A – II ; B – I ; C – IV ; D – III
(2) A – IV ; B – III ; C – I ; D – II
(3) A – I ; B – II ; C – IV ; D – III
(4) A – III ; B – II ; C – I ; D – IV

Ans. **(1)**