Sri Chaitanya IIT Academy.,India.

✪ A.P ✪ T.S ✪ KARNATAKA ✪ TAMILNADU ✪ MAHARASTRA ✪ DELHI ✪ RANCHI

A right Choice for the Real Aspirant

ICON Central Office - Madhapur - Hyderabad

Sec: Sr.Super60_NUCLEUS & STERLING_BT   Paper -1(Adv-2022-P1-Model   Date: 01-10-2023

Time: 09.00Am to 12.00Pm   RPTA-09   Max. Marks: 180

KEY SHEET

MATHEMATICS

1	**9**	2	**3**	3	**2**	4	**3**	5	**13**	6	**5**
7	**2**	8	**0**	9	**AD**	10	**ABC**	11	**ACD**	12	**BCD**
13	**AC**	14	**BC**	15	**A**	16	**B**	17	**B**	18	**A**

PHYSICS

19	**6**	20	**5**	21	**32**	22	**1**	23	**2**	24	**4.95**
25	**7.50**	26	**20**	27	**A**	28	**ABC**	29	**AC**	30	**BC**
31	**AD**	32	**ABD**	33	**B**	34	**C**	35	**C**	36	**D**

CHEMISTRY

37	**13**	38	**438**	39	**16**	40	**4**	41	**5**	42	**6**
43	**2**	44	**7**	45	**BCD**	46	**BCD**	47	**BC**	48	**A**
49	**ABCD**	50	**ABCD**	51	**A**	52	**B**	53	**C**	54	**A**

SOLUTIONS

MATHEMATICS

1. $R = P^T\left(PAP^T\right)\left(PAP^T\right).......\left(PAP^T\right)P = A^8$

$$R = \left(I+B\right)^8, B = \begin{bmatrix} \sqrt{3}-1 & -2 \\ 0 & 0 \end{bmatrix}$$

$$R = {}^8C_0 I + {}^8C_1 B + {}^8C_2 B^2 + {}^8C_3 B^3 + ...+ {}^8C_8 B^8$$

$$B^2 = \begin{bmatrix} \sqrt{3}-1 & -2 \\ 0 & 0 \end{bmatrix}\begin{bmatrix} \sqrt{3}-1 & -2 \\ 0 & 0 \end{bmatrix} = \left(\sqrt{3}-1\right)B$$

$$R = I + {}^8C_1 B + {}^8C_2\left(\sqrt{3}-1\right)B + {}^8C_3\left(\sqrt{3}-1\right)^2 B + ...{}^8C_8\left(\sqrt{3}-1\right)^7 B$$

$$= I + \frac{B}{\left(\sqrt{3}-1\right)}\left({}^8C_1\left(\sqrt{3}-1\right) + {}^8C_2\left(\sqrt{3}-1\right)^2 + ...{}^8C_8\left(\sqrt{3}-1\right)^8\right)$$

$$r_{11} = 81$$

2. $A^{-1} + B^{-1} = \left(A+B\right)^{-1} \Rightarrow \left(A^{-1}+B^{-1}\right)\left(A+B\right) = \left(A+B\right)^{-1}\left(A+B\right)$

$\Rightarrow 2I + A^{-1}B + B^{-1}A = I \qquad \Rightarrow A^{-1}B + B^{-1}A = -I$

Let $A^{-1}B = P$

$P + P^{-1} = -I \Rightarrow \qquad P^2 + I = -P \Rightarrow \qquad P^2 + P + I = O$

$\Rightarrow \left(P-I\right)\left(P^2+P+I\right) = O \Rightarrow \qquad P^3 = I$

$\Rightarrow \qquad |P| - I \Rightarrow \qquad \left|A^{-1}\right||B| = 1 \Rightarrow \qquad |A| = |B|$

3. $a_{ij} = 0 \; i \neq j$ And $a_{ij} = (n-1)^2 + i \; i = j$

Sum of the all the element of

$= (2n-1)(n-1)^2 + (2n-1)n = 2n^3 - 3n^2 + 3n - 1 = n^3 - 1 = n^3 + (n-1)^3$

So, $T_n = (-1)^n\left[n^3 + (n-1)^3\right] = (-1)^n n^3 - (-1)^{n-1}(n-1)^3 = V_n - V_{n-1}$

4. $|A - \lambda J| = 0 \quad \Rightarrow \quad \begin{bmatrix} \frac{1}{2}-\lambda & \frac{1}{2} \\ a & b-\lambda \end{bmatrix} = 0$

$$\Rightarrow \lambda^2 - \left(b + \frac{1}{2}\right)\lambda + \frac{b-a}{2} = 0$$

$A^2 = xA - yI; \quad x = b + \frac{1}{2}, y = \frac{b-a}{2}$

$A^3 = xA^2 - yA; \; x\left(xA - yI\right) - yA$

$A^3 = A \qquad \Rightarrow \qquad \left(x^2 - y - 1\right)A = xyI$

$\therefore \frac{x^2-y-1}{2} = xy \qquad \frac{x^2-y-1}{2} = 0 \;\; and \;\; xy = 0$

$if \;\; x = 0, y = -1 \; or \; y = 0, x = \pm 1$

$(a,b) = \left(\frac{3}{2}, -\frac{1}{2}\right), \left(\frac{1}{2}, \frac{1}{2}\right), \left(-\frac{3}{2}, -\frac{3}{2}\right)$

5. $AA^T = 4I \Rightarrow |A| = \pm 8$

$$A^T = 4A^{-1} = \frac{4Adj(A)}{|A|}$$

$$\Rightarrow \begin{bmatrix} a_{11} & a_{21} & a_{31} \\ a_{12} & a_{22} & a_{32} \\ a_{13} & a_{23} & a_{33} \end{bmatrix} = \frac{4}{|A|}\begin{bmatrix} c_{11} & c_{21} & c_{31} \\ c_{12} & c_{22} & c_{32} \\ c_{13} & c_{23} & c_{33} \end{bmatrix}$$

Now, $a_{ij} = \frac{4}{|A|}c_{ij} = -\frac{1}{2}c_{ij} \Rightarrow |A| = -8$

Now, $|A+4I| = |A+AA^T| = |A||I+A^T| = -2|(I+A)^T| = -8|1+A|$ $so, \frac{|A+4I|}{|A+I|} = -8 = -5\lambda$ $\lambda = \frac{8}{5}$

6. $|A-nI| = 0\begin{vmatrix} 1-n & 2 & 0 \\ 2 & 1-n & 0 \\ 0 & 0 & 1-n \end{vmatrix} = (1-n)^3 - 4(1-n)$

$\Rightarrow n = -1, 1, n_1 = -1, n_2 = 1, n_3 = 3 \qquad \Rightarrow A^3 - 3A^2 + 3I = O$

$|A||B||A|^T = |N| = n_1 n_2 n_3 = -3 = |A|^2 |B|$ $|B| = \frac{1}{3}$

$$A = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} + \begin{bmatrix} 0 & 2 & 0 \\ 2 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix} = I + B \quad B^2 = 4\begin{vmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{vmatrix}, B^3 = 8\begin{vmatrix} 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 0 \end{vmatrix}$$

$$Tr(A^k) = 3 + 2\left({}^kC_2 2^2 + {}^kC_4 2^4 + {}^kC_6 2^6 + ...\right)$$

$$= 1 + 2\left({}^kC_0\, {}^kC_2 2^2 + {}^kC_4 2^4 + ...\right) = 1 + 3^k + (-1)^k$$

7. Differentiating w.r.t to x.

$$-f'(x) = \begin{vmatrix} -\sin x & x & 1 \\ 2\cos x & x^2 & 2x \\ \sec^2 x & x & 1 \end{vmatrix} + \begin{vmatrix} \cos x & 1 & 1 \\ 2\sin x & 2x & 2x \\ \tan x & 1 & 1 \end{vmatrix} + \begin{vmatrix} \cos x & x & 0 \\ 2\sin x & x^2 & 2 \\ \tan x & x & 0 \end{vmatrix}$$

$$\Rightarrow \frac{-f'(x)}{x} = \begin{vmatrix} -\sin x & 1 & 1 \\ 2\cos x & x & 2x \\ \sec^2 x & 1 & 1 \end{vmatrix} + \begin{vmatrix} \cos x & 1 & 0 \\ 2\sin x & x & 2 \\ \tan x & 1 & 0 \end{vmatrix}$$

As $x \to 0$

$$\therefore \lim_{x\to 0} \frac{(-)f'(x)}{x} = -2$$

8. On differentiating determinant we get

$$f'(x) = \begin{vmatrix} \sin\alpha & \cos(x+\alpha) & \sin(x+\alpha) \\ \sin\beta & \cos(x+\beta) & \sin(x+\beta) \\ \sin\gamma & \cos(x+\gamma) & \sin(x+\gamma) \end{vmatrix} + \begin{vmatrix} -1+x\sin\alpha & -\sin(x+\alpha) & \sin(x+\alpha) \\ 13+x\sin\beta & -\sin(x+\beta) & \sin(x+\beta) \\ -12+x\sin\gamma & -\sin(x+y) & \sin(x+\gamma) \end{vmatrix}$$

$$+\begin{vmatrix} -1+x\sin\alpha & \cos(x+\alpha) & \sin(x+\alpha) \\ 13+x\sin\beta & \cos(x+\beta) & \cos(x+\beta) \\ -12+x\sin\gamma & \cos(x+\gamma) & \cos(x+\gamma) \end{vmatrix}$$

This determinant can be expressed as the sum of four determinant's in each of which two column's coincide after taking $\cos x, \sin x$ common from them respectively.

$\therefore$ The value of the determinant = 0

$i.e., f'(x)=0$

$\Rightarrow f(x)=a, a$ Constant function i.e., independent of x,α,β,λ.

9. $(MN)^2=3MN$ $\Rightarrow NMNMN\,M=3NMNM$

$\Rightarrow (NM)^3=3(NM)^2 \Rightarrow (NM)=3I$

$P=\frac{1}{3}I$ SO, $P+P^2+....=\left(\frac{1}{3}+\frac{1}{3^2}+.....\right)I=\frac{1}{2}I$

10. $$\Delta=\begin{vmatrix} 3 & 1+\alpha+\beta & 1+\alpha^2+\beta^2 \\ 1+\alpha+\beta & 1+\alpha^2+\beta^2 & 1+\alpha^3+\beta^3 \\ 1+\alpha^2+\beta^2 & 1+\alpha^3+\beta^3 & 1+\alpha^4+\beta^4 \end{vmatrix}$$

$$=,\Delta=\begin{vmatrix} 1 & 1 & 1 \\ 1 & \alpha & \beta \\ 1 & \alpha^2 & \beta^2 \end{vmatrix}^2=\left((1-\alpha)(1-\beta)(\alpha-\beta)\right)^2=\left(\frac{a+b+c}{a}\right)^2\left(\frac{b^2-4ac}{a^2}\right)$$

11. A) $a_{ij}=-a_{ji} \Rightarrow a_{ij}+a_{ij}=0 \Rightarrow$ A is skew symmetric matrix

C. $A^2=2A \Rightarrow A^3=2^2A \Rightarrow A^6=2^5A$

D. A^6B^7 is skew symmetric matrix of odd order

12. $P^T(P+Q)Q^T=(P+Q)^T \Rightarrow |P+Q|=0, P^T(P-I)=-(P-I)^T$

Either $|P||P-1|=-|P-1|$ or $|Q||Q-1|=-|Q-1|$, because $|P|\ \ |Q|<0$

$P\left(P^{-1}+Q^{-1}\right)Q=P+Q \Rightarrow \left|P^{-1}+Q^{-1}\right|=-|P+Q|=0$

13. $A_1+A_2+........A_n=\sum_{i=1}^{N}A_1$

$$=\begin{bmatrix} \sum_{i=1}^{n}C_{i-1}^2 & 0 \\ 0 & \sum_{i=1}^{n}C_I^2 \end{bmatrix}=\begin{bmatrix} {}^{2n}C_n-1 & 0 \\ 0 & {}^{2n}C_n-1 \end{bmatrix} \quad \therefore K_1=K_2=2n_{C_n}-1$$

14. conceptual

15. $$A(t)=\begin{bmatrix} 2\cos t & 1 & 0 \\ 1 & 2\cos t & 1 \\ 0 & 1 & 2\cos t \end{bmatrix}$$

$|A(t)|=2\cos t\left(4\cos^2 t-1\right)-2\cos t=8\cos^3 t-4\cos t$

$|A(t)|=4\cos t\cos 2t$

(A) $|A(t)|=4 \Rightarrow t=-2n\pi, n\in 1$ $\Rightarrow t=-2\pi,0,2\pi,4\pi$

(B) $\left|A\left(\frac{\pi}{17}\right)\right|\left|A\left(\frac{4\pi}{17}\right)\right|=\left|16\cos\frac{\pi}{17}\cos\frac{2\pi}{17}\cos\frac{4\pi}{17}\cos\frac{8\pi}{17}\right|=\left|\frac{\sin\frac{16\pi}{17}}{\sin\frac{\pi}{17}}\right|=1$

(C) $|A(t)|+|A(2t)|=4\cos t\cos 2t+4\cos 2t\cos 4t\le 8$

(D) $\int_0^{\pi}16\cos t\cos 2t\cos 4t\cos 8t\,dt=\int_0^{\pi}\frac{\sin 16t\,dt}{\sin t}=\int_0^{\pi}\left(\frac{\sin 16t}{\sin t}+\frac{\sin(16\pi-16t)}{\sin(\pi-t)}\right)dt \quad =0$

16. a)

$$|M_r| = \frac{1}{r-1} - \frac{1}{r}$$

$$\therefore |M_2| + |M_3| + ... + |M_n| = 1 - \frac{1}{n}$$

$$\underset{n\to\infty}{Lt}\left(|M_2| + |M_3| + ... + |M_n|\right) = \underset{n\to\infty}{Lt}\left(1 - \frac{1}{n}\right)^{\log_e^n} = 1$$

b)2

c) $|C| = |A|^2 = 16$

d) $A^2 = \begin{pmatrix} 0 & 2 \\ -2 & 0 \end{pmatrix}$ and $A = \begin{pmatrix} -4 & 0 \\ 0 & -4 \end{pmatrix}$

17. $A^T D = DA^T$

$DD^T = D^T D = I$

$\Rightarrow$ $DD^T A^T D = DA^T$ $\quad$ $DA^{-1} = DA^T \Rightarrow A^{-1} = A^T$

$\Rightarrow$ $BC^2 = B^T$ $\quad$ $B = B^T$

(A) $B = B^{-1}$ $\Rightarrow$ $B^2 = I$

$\Rightarrow$ $|B^{2018}C| = |C| = \pm 1$

(B) $\left(ACA^T\right)^{2019} = \left(ACA^T\right)\left(ACA^T\right).....\left(ACA^T\right) = AC^{2019}A^T = AC^kA^T$ $\quad \Rightarrow k$ is odd

(C) $|ACA^T| = |A|^2|C| = |C| = \pm 1$

(D) $\left|BB^T\left(B^{-1}\right)^2\right| + \left|\left(AA^T\right)^{2018}\right| = 1 + 1 = 2$

18. As A and B are invertible matrices A^{-1}, B^{-1} both exist, Also, for every positive integer, A^n and B^n are invertible .

Suppose $(AB)^n = A^nB^n$ holds three consecutive positive integer m, m + 1 and m + 2. We have $(AB)^m = A^mB^m$ ………………..(1)

$(AB)^{m+1} = A^{m+1}B^{m+1}$ $\quad$ (2)

And $(AB)^{m+2} = A^{m+2}B^{m+2}$ $\quad$ (3)

From (2), we have

$A^{m+1}B^{m+1} = (AB)^{m+1} = (AB)^m(AB)$ $\quad \Rightarrow A^mAB^mB = A^mB^mAB$

[using (1)]

Since A^m and B are invertible matrices

$AB^m = B^mA$……………………(4)

Similarly, using (2) and(3) we can show that

$AB^{m+1} = B^{m+1}A$…………………………..(5)

We have $(AB)B^m = AB^{m+1} = B^{m+1}A$

[using (5)] $\quad = B\left(B^mA\right) = B\left(AB^m\right) = (BA)B^m$

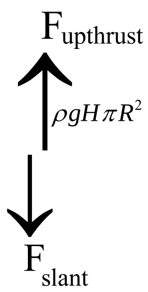
[Using (4)] $\quad$ Thus , $(AB)B^m = (BA)B^m$

As B^m is an invertible matrix, we can cancel B^m from both the sides to obtain AB – BA

$\Rightarrow A^{-1}BA = B$ and $B^{-1}AB = A$ etc.,

PHYSICS

19.



Here, $\rho g H \pi R^2 - F_{slant} = F_{upthrust} = \frac{1}{3}\pi R^2 H \rho g$

$F_{slant} = \frac{2}{3}\pi R^2 H \rho g$

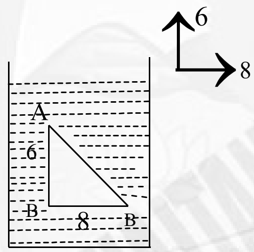
20.

Taking moments about end point

$(6-X)^2 .\ A\rho_{\omega}.\frac{g}{2} = 18.A\rho_r.g$

X = 1 m

21.



$(P_{B^1} - P_A) = \rho_0 (g+6)6 \quad .....(i)$

$(P_B - P_B) = \rho_0 (8)8 \quad .....(ii)$

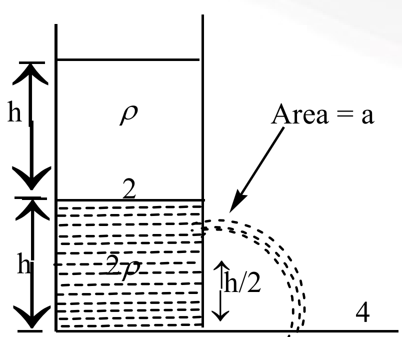
22. Velocity of efflux, $V = \sqrt{2gh}$

Velocity of top layer $= \frac{AV}{A_0} = \frac{A}{A_0}\sqrt{2gh}$

$\therefore$ Acceleration of top layer $= \frac{d}{dt}\left(\frac{A}{A_0}\sqrt{2gh}\right)$

$\frac{A}{A_0}\sqrt{2g} \times \frac{1}{2\sqrt{h}} \times \frac{dh}{dt} = \frac{A}{A_0}\sqrt{2g} \times \frac{1}{2\sqrt{h}} \times \frac{A}{A_0}\sqrt{2gh} \qquad \left(\frac{A}{A_0}\right)^2 g = 1$

23.



Applying Bernoulli's equation

$P_0 + rgh + (2r)(g)\frac{?}{?} = P_0 + \frac{1}{2}(2r)v^2 \qquad \Rightarrow \ v = \sqrt{2gh}$

This is required velocity of efflux

Applying continuity equation between 3 and 4 cross-section.

$av = a_1 v_1$

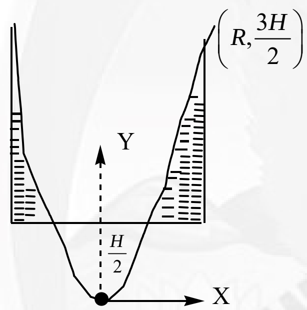
Applying Bernoulli's equation between 3 & 4

$$P_{atm} + \frac{1}{2}(2\rho)v^2 + 2\rho g \times \frac{h}{2} = P_{atm} + \frac{1}{2}(2\rho)v_1^2 + 0$$

$$\rho v^2 + \rho gh = \rho v_1^2 = 3gh \qquad a_1 = \frac{av}{v_1} = \frac{\sqrt{6}.\sqrt{2gh}}{\sqrt{3gh}} = 2\ cm^2$$

24. $V = \sqrt{\dfrac{2gh}{1-\left(\dfrac{1}{10}\right)^2}} \qquad F = (\rho)\left(\dfrac{A_0}{10}\right)V^2 \qquad = \dfrac{20}{99}\rho g H A_0$

25.



$$y = \frac{\omega^2 X^2}{2g}, \omega = \frac{\sqrt{3gH}}{R}$$

26. $P_0 + 6\rho gh = \rho_0 + \frac{1}{2}3\rho V^2 \qquad V = 2\sqrt{gh}$

27. **For cone A**

$\frac{V_i}{V} = \frac{1}{3} \qquad V_i = \frac{1}{3}V$

$$\frac{1}{3}\times\pi\times\frac{h_1^2}{4}\times h_1 = \frac{1}{3}\times\frac{1}{3}\times\pi R^2\times 2R$$

$$\frac{h_1^3}{4} = \frac{2}{3}R^3 \qquad h_1^3 = \frac{8}{3}R^3 \qquad h_1 = \frac{2}{3\sqrt{3}}R$$

For cone B

$$\frac{V - V_i}{V} = \frac{2}{3} \qquad \frac{1}{3}\times\pi\times\frac{h_2^2}{4}\times h_2 = \frac{2}{3}\times\frac{1}{3}\pi R^2\times 2R$$

$$h_2 = 2\sqrt[3]{\frac{2}{3}}R \qquad \frac{h_1}{h_2} = \frac{1}{2^{\left(\frac{1}{3}\right)}} = (2)^{-\frac{1}{3}}$$

Time period:

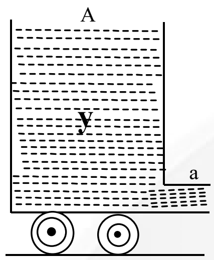
$$\rho\pi\left(\frac{h_1^2}{4}\right)xg = \sigma\left(\frac{1}{3}\pi R^2\right)(2R)a \qquad \omega = \frac{3}{2}\sqrt{\frac{gh_1^2}{2R^3}} \qquad T = 3^{-\frac{2}{3}}\left[2\pi\sqrt{\frac{2R}{g}}\right]$$

28. Pressure difference will accelerate the fluid.

29. Point 1 and 5 are open to atmosphere.

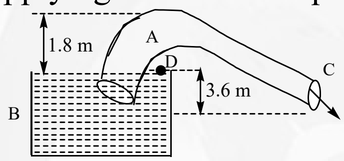
30. Force of upthrust will be there on mass m shown in given figure, so A weighs less than 2 kg. Balance will show sum of load of beaker and reaction of upthrust so it reads more than 5kg.

31. $V=\sqrt{2gy}$ $\qquad F=\rho\, a\; 2gy$



$(\rho Ay)\alpha=\rho a2gy \Rightarrow \alpha=\frac{a}{A}2g$

32. Applying Bernoulli's equation at C and D, we have



$P_0+0+\rho g(3.6)=P_0+\frac{1}{2}\rho v^2+0 \qquad \Rightarrow\; v=6\sqrt{2}\; m/s$

Volume blown per unit time $=av=\pi r^2 v=96\sqrt{2}\times10^{-4}m^3/s$

Similarly, at A and C,

$P_A+\frac{1}{2}\rho v^2+\rho g(3.6+1.8)=P_0+\frac{1}{2}\rho vH2+0 \qquad \Rightarrow\; P_A=0.46\times10^5 N/m^2$

33. Pressure at bottom of vessel $\quad P=2\rho gh$

Force on bottom of vessel $\quad F=2\rho gh\, A_2$

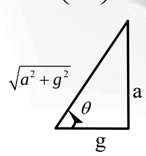
Force exerted by vessel at level x on liquid is $\quad F=h\rho g(A_2-A_1)$

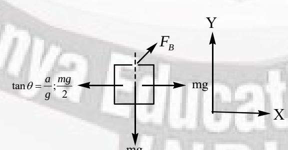
34 Force of buoyancy $F_B=V_{in}\rho g=Ah\rho g$

Hydrostatic force on side wall of cube $F_H=$ average pressure x area $F_H=\frac{1}{2}\rho ghA$

Impact force on vessel $F=Av^2\rho$, Aerodynamic force on flat roof $=Av^2\rho$

35 A) $F_B=\rho\left(\frac{m}{\sigma}\right)g_{eff}=m\left(\frac{\rho}{\sigma}\right)\sqrt{a^2+g^2}$





FBC of cube w.r.t container

So $\cos\theta=\frac{g}{\sqrt{a^2+g^2}}$ and $\sin\theta=\frac{a}{\sqrt{a^2+g^2}}$

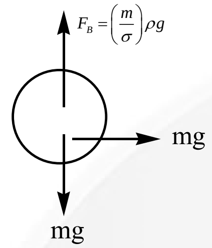
Let $a_x=$ acc of cube w.r.t container in x-direction $mg+F_B\sin\theta-\frac{mg}{2}=ma_x$

$a_x^1=\frac{g}{2}+\frac{\rho}{\sigma}a \Rightarrow a_x^1=\frac{g}{2}+\frac{\rho}{\sigma}.\frac{g}{2}$

Hence $a_x^1 = \frac{g}{2} + \frac{\rho}{\sigma} a \Rightarrow a_x^1 = \frac{g}{2} + \frac{\rho}{\sigma} \cdot \frac{g}{2}$

In Y-direction : $F_B \cos\theta - mg = ma_y$

$$\Rightarrow m\left(\frac{\rho}{\sigma}\right)\sqrt{a^2+g^2}\,\frac{g}{\sqrt{a^2+g^2}} - mg = ma_y$$

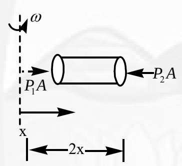


FBD for sphere

$$a_y = g\left[\frac{\rho}{\sigma} - 1\right] = g\left[\frac{\rho}{\sigma}\right] \therefore \frac{a_x}{a_y} = \frac{(2\sigma+\rho)}{2(\rho-\sigma)}$$

B) $a_x = g$ $\quad a_y = \frac{-mg + m\left(\frac{\rho}{\sigma}\right)g}{m} = \left(\frac{\rho-\sigma}{\sigma}\right)g \quad \therefore \frac{a_x}{a_y} = \frac{\sigma}{\rho-\sigma}$

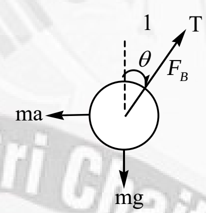
C) $(P_1 - P_2)A = m\,a_x$



FBD of cylinder

$$\frac{\rho\omega^2 2}{}\left[(2x)^2 - x^2\right]A = m\,a_x \qquad \frac{\rho}{2}\left(\frac{2g}{3x}\right)3x^2 A = (A-x)\sigma a_x \therefore \frac{a_x}{g} = \frac{\rho}{\sigma}$$

D) When cart is not filled with liquid, $\tan\theta = \frac{a}{g}$



FBD of pendulum

When cart is filled with liquid

Cart : $(T + F_B)\sin\theta^1 = ma$ ……(1)

$\tan\theta^1 = \frac{a}{g}$ ….(2) $\qquad (F_B + T)\cos\theta^1 = mg$ …..(3)

$$\therefore \frac{\tan\theta^1}{\tan\theta} = \frac{1}{1} = \frac{\theta^1}{\theta} = \frac{1}{1}$$

36. If volume of water displaced is equal to volume of formed water due to melting of ice then water level remains same.

CHEMISTRY

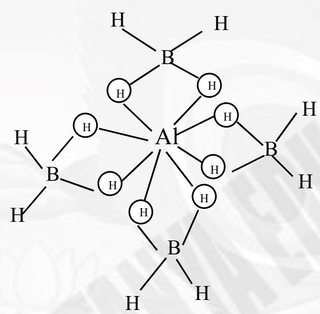
37.

(c) $BCl_3 + NH_4Cl \rightarrow B_3N_3Cl_3H_3 \xrightarrow{NaBH_4} B_3N_3H_6 \xrightarrow{H_2O} NH_3 + H_3BO_3 + H_2$

38. $Li_3N + 4H_2O \rightarrow 3LiOH + NH_4OH$

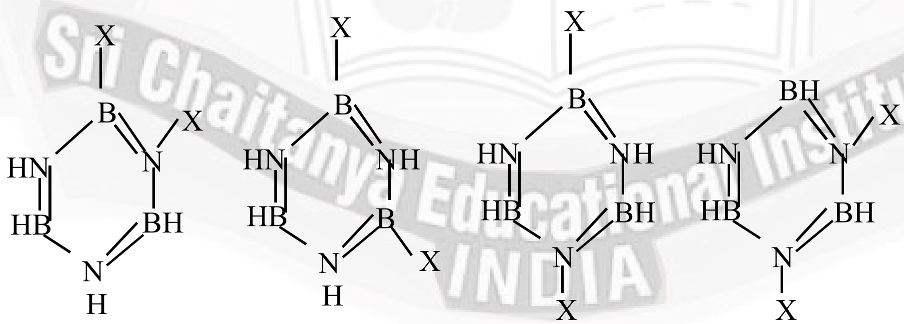
Therefore, mass of HCl required $= 12 \times 36.5 = 438g$

39. *(a)* The total number of ligands attached to a central ion is called the coordination number of that ion. The coordination number of aluminium ion $\left[Al\left(BH_4\right)_4\right]^-$ is 8, because eight ligands are attached to aluminium ion.



$\left[Al\left(BH_4\right)_4\right]^-$ contain the complex ion BH_4^- which is formed by sp^3 – hybridization of the orbitals of boron. In every tetrahedral structure of BH_4^- ion is attached to aluminium therefore eight bridging hydrogen atoms are attached to central atom.

40. (4) The number of isomeric structure of disubstituted borazine $\left(B_3N_3H_4X_2\right)$ is Four



1,2(B,N) 1,3(B,B) 1,4(B,N) 1,3(N,N)

41. X=5 , Y=0

42. $3B_2H_6 + 6NH_3 \xrightarrow{200^0 C} 2B_3N_3H_6 + 12H_2$

43. 1 H_2O_2 is almost colourless

2 Magnesium is present in chlorophyll

44. all are correct

45 . B,C,D

46. $CaCO_3 \xrightarrow{\Delta} CaO + CO_2$

$CaO + H_2O \rightarrow Ca(OH)_2$

$Ca(OH)_2 + SO_2 \rightarrow CaSO_3 + H_2O$

White Ppt

$CaSO_3 + SO_2 + H_2O \rightarrow Ca(HSO_3)_2$

Soluble

47. $Li + O_2 \rightarrow LiO_2; Li + N_2 \rightarrow Li_3N; Mg + O_2 \rightarrow MgO; Mg + N_2 \rightarrow Mg_3N_2$

$Li_3N + H_2O \rightarrow NH_3 + LiOH;$

$Mg_3N_2 + H_2O \rightarrow NH_3 + Mg(OH)_2$

$NH_3 \xrightarrow{HCl}$ White dense fumes

48. In Borax, Two Boron atoms will show sp^2 and other 2 Boron atoms show sp^3

49. Graphite is thermodynamically more stable and more reactive than diamond Graphite is an aromatic compound

50. Zeolites are 3D silicates in which some of the SiO_4^{4-} units are replaced by $A\ell O_4^{5-}$ ions. Due to honey comb structure they can take up small molecules. The sodium ions present in zeolites are exchanged with cations like Mg^{2+} or Ca^{2+} during the softening of hard water.

51. (A) $2Na_2O \xrightarrow{400^0 C} Na_2O_2 + 2Na$

(B) $4LiNO_3 \rightarrow 2Li_2O + 4NO_2 + O_2$

(C) $2Na + O_2(excess) \xrightarrow{350^0 C} Na_2O_2$

(D) $K(NH_3)_x^{+} + [e(NH_3)y]^{-}$ Blue colour solution

52. (A) $4H_3BO_3 + 2NaOH \rightarrow 7H_2O + Na_2B_4O_7$

(B) $Na_2B_4O_7 + H_2O \rightarrow H_3BO_3 + NaOH$

(C) $K_3BO_3 + H_2SO_4 \rightarrow K_2SO_4 + H_3BO_3$

(D) $B_2H_6 + 6H_2O_{(excess)} \rightarrow 2H_3BO_3 + 6H_2 \uparrow$

53. Hybridization concept

54. (A) $Cl_2 + \text{cold and dilute } 2NaOH \xrightarrow{0^0 C} NaCl + NaOCl + H_2O$

(B) $Cl_2 + \text{hot and conc. } 6NaOH \xrightarrow[\Delta]{>50^0 C} 5NaCl + NaClO_3 + 3H_2O$

(C) $2NaNO_3 \xrightarrow{\Delta} 2NaNO_2 + O_2$

(D) $2ClO_2 + H_2O \rightarrow HClO_2 + HClO_3$

+3 +5

$HClO_2 + NaOH \rightarrow NaClO_2 + H_2O$

$HClO_3 + NaOH \rightarrow NaClO_3 + H_2O$