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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**

01-10-2023\_Sr.Super60\_NUCLEUS&STERLING\_BT\_Jee-Adv(2022-P1)\_RPTA-09\_Syllabus

**MATHEMATICS : Matrices & Determinants**

**PHYSICS : Fluid statics & Dynamics**

**CHEMISTRY : 1.s-Block Elements, 2.Group-13, 3.Group 14**

**Name of the Student:** \_\_\_\_\_

**H.T. NO:**

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**JEE-ADVANCE-2022-P1-Model**

Time:3Hr's

**IMPORTANT INSTRUCTIONS**

Max Marks: 180

**MATHEMATICS:**

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 1 – 8)	Questions with Numerical Value Answer Type	+3	0	8	24
Sec – II(Q.N : 9 – 14)	Questions with Multiple Correct Choice with partial mark	+4	-2	6	24
Sec – III(Q.N : 15 – 18)	Matching Type	+3	-1	4	12
<b>Total</b>				<b>18</b>	<b>60</b>

**PHYSICS:**

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 19 – 26)	Questions with Numerical Value Answer Type	+3	0	8	24
Sec – II(Q.N : 27 – 32)	Questions with Multiple Correct Choice with partial mark	+4	-2	6	24
Sec – III(Q.N : 33 – 36)	Matching Type	+3	-1	4	12
<b>Total</b>				<b>18</b>	<b>60</b>

**CHEMISTRY:**

Section	Question Type	+Ve Marks	- Ve Marks	No.of Qs	Total marks
Sec – I(Q.N : 37 – 44)	Questions with Numerical Value Answer Type	+3	0	8	24
Sec – II(Q.N : 45 – 50)	Questions with Multiple Correct Choice with partial mark	+4	-2	6	24
Sec – III(Q.N : 51 – 54)	Matching Type	+3	-1	4	12
<b>Total</b>				<b>18</b>	<b>60</b>



**MATHEMATICS****Max Marks: 60****SECTION – I  
(NUMERICAL VALUE TYPE)**This section contains **EIGHT (08)** questions.

- The answer to each question is a **NUMERICAL VALUE**.
- For each question, enter the correct numerical value of the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer. If the numerical value has more than two decimal places, **truncate/round-off** the value to **TWO** decimal places.

- Answer to each question will be evaluated according to the following marking scheme :

Full Marks: +3 **ONLY** if the correct numerical value is entered ;

Partial Mark: 0 In all other cases.

1. Let  $A = \begin{bmatrix} \sqrt{3} & -2 \\ 0 & 1 \end{bmatrix}$  and P can be a  $2 \times 2$  real matrix such that  $PP^T = I$  (Where  $I$  is Identity matrix of order 2). If  $Q = PAP^T$  and  $R = [r_{ij}]_{2 \times 2} = P^T Q^8 P$ , then  $\sqrt{r_{11}}$  is equal to
2. For any integer  $n \geq 5$ , let A, B are two  $n \times n$  invertible matrices with real entries satisfy the equation  $A^{-1} + B^{-1} = (A + B)^{-1}$ . If  $|A| = 3$ , then find the value of  $|B|$ .
3. Let  $A_n$ , ( $n \in N$ ) be a matrix of order  $(2n-1) \times (2n-1)$ , such that  $a_{ij} = 0 \forall i \neq j$  and  $a_{ij} = n^2 + i + 1 - 2n \forall i = j$  where  $a_{ij}$  denotes the element of  $i^{\text{th}}$  row and  $j^{\text{th}}$  column of

$$A_n. \text{ Let } T_n = (-1)^n \times (\text{sum of all the elements of } A_n). \text{ Find the value of } \left[ \frac{\sum_{n=1}^{102} T_n}{520200} \right], \text{ where}$$

[ ] represents the greatest integer function.

4. Let  $P = \left\{ (a, b) \left| A^3 = A, \text{ where } A = \begin{bmatrix} 1 & 1 \\ 2 & 2 \end{bmatrix} \right. \right\}$ , then  $n(P) =$  (where  $n(P)$  is number of elements in P)
5. Let  $A = [a_{ij}]_{3 \times 3}$  be a matrix such that  $AA^T = 4I$  and  $2a_{ij} + c_{ij} = 0$  where  $c_{ij}$  is the cofactor of  $a_{ij} \forall i \& j$ ,  $I$  is the unit matrix of order 3 and  $A^T$  is the transpose of the matrix A.

$$\text{If } \begin{vmatrix} a_{11} + 4 & a_{12} & a_{13} \\ a_{21} & a_{22} + 4 & a_{23} \\ a_{31} & a_{32} & a_{33} + 4 \end{vmatrix} + 5\lambda \begin{vmatrix} a_{11} + 1 & a_{12} & a_{13} \\ a_{21} & a_{22} + 1 & a_{23} \\ a_{31} & a_{32} & a_{33} + 1 \end{vmatrix} = 0 \text{ then } \lambda = \frac{a}{b} \text{ where } a \text{ and } b$$

are coprime positive integers then the value of  $a+b$  is \_\_\_\_\_





6. Let there exists a matrix B such that  $ABA^T = N$ , where  $A = \begin{bmatrix} 1 & 2 & 0 \\ 2 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$  and N is a diagonal matrix of form  $N = \text{diag}(n_1, n_2, n_3)$  where  $n_1, n_2, n_3$  are three values of n satisfying the equation  $|A - nI| = 0, n_1 < n_2 < n_3$ . Trace of matrix  $A^{20}$  is equal to  $3^{20} + k$ , then  $k + n_1 + n_2 + n_3 = ?$
7. Let  $f(x) = \begin{vmatrix} \cos x & -x & 1 \\ 2 \sin x & -x^2 & 2x \\ \tan x & -x & 1 \end{vmatrix}$  then  $\lim_{x \rightarrow 0} \frac{f'(x)}{x}$
8. The determinant  $\begin{vmatrix} -1 + x \sin \alpha & \cos(x + \alpha) & \sin(x + \alpha) \\ 13 + x \sin \beta & \cos(x + \beta) & \sin(x + \beta) \\ -12 + x \sin \gamma & \cos(x + \gamma) & \sin(x + \gamma) \end{vmatrix}$  is equal to  $f(x)$ . then value of  $2f(2) - f(1) - f(3)$  is \_\_\_?

**SECTION – II**  
**(ONE OR MORE CORRECT ANSWER TYPE)**

This section contains **SIX (06)** questions.

- Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated according to the following marking scheme :

Full Marks : +4 **ONLY** if (all) the correct option(s) is(are) chosen;

Partial Marks : +3 If all the four options are correct but **ONLY** three options are chosen;

Partial Marks : +2 If three or more options are correct but **ONLY** two options are chosen, both of which are correct ;

Partial Marks : +1 If two or more options are correct but **ONLY** two options are chosen, and it is a correct option ;

Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered);

Negative Marks : -2 In all other cases.

9. Let  $M = [a_{ij}]_{3 \times 2}$  and  $N = [b_{ij}]_{2 \times 3}$  be two matrices such that  $(MN)^2 = 3MN$  and  $\det(NM) \neq 0$ , then choose the correct option(s) ( $P$  is  $2 \times 2$  matrix)
- A)  $\det(NM) = 9$
- B) If  $P(NM) = I$ , then  $\lim_{n \rightarrow \infty} \det(P + P^2 + P^3 + \dots + P^n) = 9$
- C)  $\det(NM) = 27$
- D) If  $P(NM) = I$ , then  $\lim_{n \rightarrow \infty} \det(P + P^2 + P^3 + \dots + P^n) = \frac{1}{4}$





10.  $S_n = \alpha^n + \beta^n$  when  $\alpha, \beta$  are real and distinct roots of  $ax^2 + bx + c = 0$ ,  $a, b, c, n \in N$  if  $\Delta = \begin{vmatrix} 3 & 1+S_1 & 1+S_2 \\ 1+S_1 & 1+S_2 & 1+S_3 \\ 1+S_2 & 1+S_3 & 1+S_4 \end{vmatrix}$ ,  $S = \begin{vmatrix} b & 2a \\ 2c & b \end{vmatrix}$  then which of the following is correct ( $\Delta$  is rational)
- A)  $\frac{a^4 \Delta}{S}$  is divisible by  $(a+b+c)^2$       B)  $\frac{a^4 \Delta}{S}$  is a perfect square
- C)  $a^4 \Delta$  is divisible by  $b^2 - 4bc$       D)  $\frac{a^4 \Delta}{S}$  is divisible by  $a^2 b^2 c^2$
11. Which of the following is/are correct?
- A) If  $A$  is a  $n \times n$  matrix such that  $a_{ij} = (i^2 + j^2 - 5ij) \cdot (j-i) \forall i$  and  $j$  then  $\text{trace}(A) = 0$
- B) If  $A$  is a  $n \times n$  matrix such that  $a_{ij} = (i^2 + j^2 - 5ij) \cdot (j-i) \forall i$  and  $j$  then  $\text{trace}(A) \neq 0$
- C) If  $P$  is a  $3 \times 3$  orthogonal matrix  $\alpha, \beta, \gamma$ , are the angles made by a straight line with  $OX, OY, OZ$  and  $A = \begin{bmatrix} \sin^2 \alpha & \sin \alpha \cdot \sin \beta & \sin \alpha \cdot \sin \gamma \\ \sin \alpha \cdot \sin \beta & \sin^2 \beta & \sin \beta \cdot \sin \gamma \\ \sin \alpha \cdot \sin \gamma & \sin \beta \cdot \sin \gamma & \sin^2 \gamma \end{bmatrix}$  and  $Q = P^T A P$ , then  $PQ^6 P^T = 32A$
- D) If matrix  $A = [a_{ij}]_{3 \times 3}$  and matrix  $B = [b_{ij}]_{3 \times 3}$  where  $a_{ij} + a_{ji} = 0$  and  $b_{ij} - b_{ji} = 0 \forall i$  and  $j$  then  $A^6 B^7$  is a singular matrix
12. If  $P$  and  $Q$  are two  $3 \times 3$  non-identity matrices with real entries such that  $PP^T = I, QQ^T = I$  ( $P^T, Q^T$  are transpose of matrices  $P$  and  $Q$  respectively) and  $\det(PQ) < 0$ , then which of the following is /are always correct (where  $\det$  stands for determinant of a matrix)
- A)  $\det(P+Q) < 0$
- B)  $\det(P+Q) = 0$
- C) at least one of the  $\det(P-I)$  or  $\det(Q-I)$  will be zero
- D)  $\det(P^{-1} + Q^{-1}) = \det(P+Q)$





13. Let  $C_k = {}^nC_k$  for  $0 \leq k \leq n$  and  $A_i = \begin{pmatrix} C_{i-1}^2 & 0 \\ 0 & C_i^2 \end{pmatrix}$  for  $i \geq 1$  and

$$A_1 + A_2 + \dots + A_n = \begin{pmatrix} k_1 & 0 \\ 0 & k_2 \end{pmatrix}, \text{ then}$$

A)  $k_1 = k_2$       B)  $k_1 + k_2 = {}^{2n}C_n + 1$       C)  $k_1 = {}^{2n}C_n - 1$       D)  $k_2 = {}^{2n}C_{(n+1)}$

14. A is matrix of order  $3 \times 3$  and  $a_{ij}$  is its elements of  $i^{\text{th}}$  row and  $j^{\text{th}}$  column. If

$$a_{ij} + a_{jk} + a_{ki} = 0 \text{ holds for all } 1 \leq i, j, k \leq 3 \text{ then}$$

A) A is a non-singular matrix      B) A is a singular matrix  
C)  $\sum_{1 \leq i, j \leq 3} a_{ij}$  is equal to zero      D) A is a symmetric matrix

### SECTION – III (MATCHING TYPE)

This section contains **FOUR (04)** Matching List Sets.

- Each set has **ONE** Multiple Choice Question.
  - Each set has **TWO** lists : **List-I** and **List-II**.
  - List-I** has **Four** entries (I), (II), (III) and (IV) and **List-II** has **Five** entries (P), (Q), (R), (S) and (T).
  - FOUR** options are given in each Multiple Choice Question based on **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.
  - Answer to each question will be evaluated according to the following marking scheme :
- Full Marks: +3 **ONLY** if the option corresponding to the correct combination is chosen;  
Zero Marks: 0 If none of the options is chosen (i.e. the question is unanswered);  
Negative Marks: -1 In all other cases.

15. Let  $A(t) = [a_{ij}]$  is a matrix of order  $3 \times 3$  given by  $a_{ij} = \begin{cases} 2 \cos t & \text{if } i = j \\ 1 & \text{if } |i - j| = 1, \text{ then} \\ 0 & \text{other wise} \end{cases}$

	Column-I		Column-II
A)	The number of $t$ in interval $[-2\pi, 4\pi]$ such that $ A(t)  = 4$ is equal to	P)	0
B)	$\left  A\left(\frac{\pi}{17}\right) \right  \left  A\left(\frac{4\pi}{17}\right) \right $ is equal to	Q)	1
C)	The maximum value of $ A(t)  +  A(2t) , \forall t \in R$ is equal to	R)	4
D)	$\int_0^\pi  A(t)   A(4t)  dt$ is equal to	S)	6
		T)	8

A) A-R, B-Q, C-T, D-P

B) A-Q, B-T, C-P, D-R

C) A-T, B-P, C-R, D-Q

D) A-P, B-R, C-Q, D-T







16.

	LIST - I		LIST - II
1)	<p>If <math>r &gt; 1, M_r = \begin{vmatrix} r-1 &amp; \frac{1}{r} \\ 1 &amp; \frac{1}{(r-1)^2} \end{vmatrix}</math> then</p> <p><math>\lim_{n \rightarrow \infty} ( M_2  +  M_3  +  M_4  + \dots +  M_n )^{\log_e^n} =</math></p>	P)	2
2)	<p>If <math>\begin{vmatrix} 1 &amp; \cos \alpha &amp; \cos \beta \\ \cos \alpha &amp; 1 &amp; \cos \gamma \\ \cos \beta &amp; \cos \gamma &amp; 1 \end{vmatrix} = \begin{vmatrix} 0 &amp; \cos \alpha &amp; \cos \beta \\ \cos \alpha &amp; 0 &amp; \cos \gamma \\ \cos \beta &amp; \cos \gamma &amp; 0 \end{vmatrix}</math> then</p> <p><math>\sin^2 \alpha + \sin^2 \beta + \sin^2 \gamma =</math></p>	Q)	4
3)	If $A = \begin{bmatrix} 3 & 1 \\ -1 & 1 \end{bmatrix}$ and $C = (BAB^{-1})(B^{-1}A^T B)$ then $\sqrt{\det(C)}$ can be	R)	1
4)	If $A = \begin{bmatrix} 1 & 1 \\ -1 & 1 \end{bmatrix}$ and $A^4 = -\lambda I$ then $\lambda =$	S)	3
		T)	0

A) 1-P,2-P,3-Q,4-R

B) 1-R,2-P,3-Q,4-Q

C) 1-R,2-Q,3-P,4-T

D) 1-T,2-Q,3-Q,4-P



17. Let A, B, C, D be non singular matrices of order  $3 \times 3$  such that  $(AA^T)BC^2 = B^T$  and  $C^2 = I$  and D is an orthogonal matrix such that  $A^T$  and D commute with each other and  $D^T A^T D = A^{-1}$ , then

	Column-I		Column-II
A)	If $B = B^{-1}$ , then $ B^{2018}C $ can be equal to	P)	-1
B)	If $(ACA^T)^{2019} = AC^k A^T$ then k can be equal to	Q)	0
C)	$ ACA^T $ can be equal to	R)	2
D)	$ BB^T(B^{-1})^2  +  (AA^T)^{2018} $ is equal to	S)	3
		T)	4

A) A-S,B- P,C- R,D- P

B) A-P,B-S,C-P,D-R

C) A-P,B- R,C- S,D- P

D) A-P,B- S,C- R,D- R

18. Let A and B be two non-singular matrices such that  $(AB)^k = A^k B^k$  for three consecutive positive integral value's of k.

	Column-I		Column-II
A)	$ABA^{-1}$	P)	$A^2$
B)	$BAB^{-1}$	Q)	B
C)	$AB^2 A^{-1}$	R)	A
D)	$BA^2 B^{-1}$	S)	$B^2$
		T)	AB

A) A-Q,B-R,C-S,D-P

B) A-R,B-S,C-P,D-Q

C) A-S,B-P,C-Q,D-R

D) A-P,B-Q,C-R,D-S





## PHYSICS

Max Marks: 60

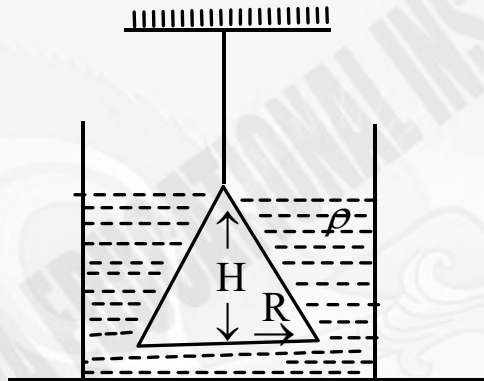
SECTION – I  
(NUMERICAL VALUE TYPE)This section contains **EIGHT (08)** questions.

- The answer to each question is a **NUMERICAL VALUE**.
- For each question, enter the correct numerical value of the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer. If the numerical value has more than two decimal places, **truncate/round-off** the value to **TWO** decimal places.
- Answer to each question will be evaluated according to the following marking scheme :

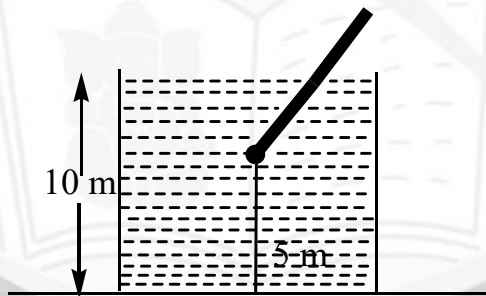
Full Marks: +3 **ONLY** if the correct numerical value is entered ;

Partial Mark: 0 In all other cases.

19. A cone of radius  $R$  and height  $H$ , is hanging inside a liquid density  $\rho$  by means of a string with its base at depth  $H$  as shown. If force due to the liquid on the slant surface of cone is  $\frac{4\pi R^2 \rho g H}{N}$ , then find  $N$  (Ignore atmospheric pressure).

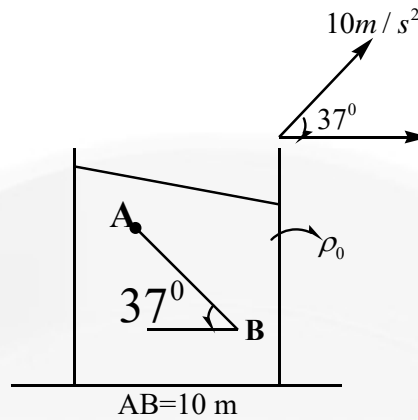


20. A rod of length 6 m has specific gravity  $\rho = 25/36$ . One end of the rod is tied to 5 m long rope, which in turn is tied to the floor of a pool 10 m deep in equilibrium. Find the length of the part of rod in side of water in metre.

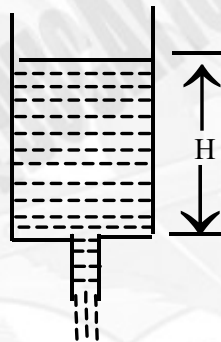


21. A vessel containing liquid of density  $\rho_0$  is moving with an acceleration  $10 \text{ m/s}^2$  in vertical  $x$ - $y$  plane as shown, then the value of  $(P_B - P_A)$  is given by  $n\rho_0$ . Find value of  $n$ . ( $P_A$  and  $P_B$  are the pressure at A and B). ( $g = 10 \text{ m/s}^2$ )

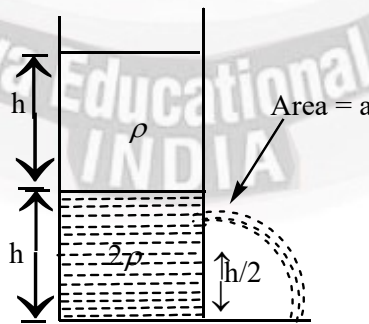




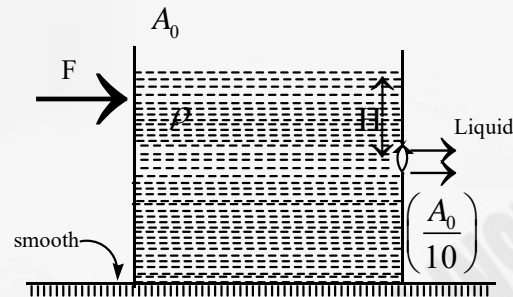
22. A tank of cross-sectional area  $A_0$  is filled with a liquid. A small orifice of area  $A$  ( $A \ll A_0$ ) is present at the bottom of tank. At a moment, the height of liquid in the tank is  $H$ , what is magnitude of acceleration of top layer of liquid at this moment as a multiple of  $\left(\frac{A}{A_0}\right)^2 g$ ?



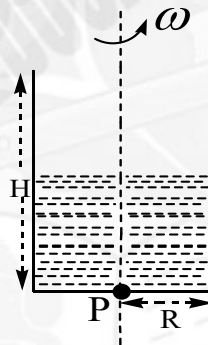
23. A fixed cylindrical tank having large cross-sectional area is filled with two liquids of densities  $\rho$  and  $2\rho$  and in equal volumes as shown in figure. A small hole of area of cross-section  $a = \sqrt{6} \text{ cm}^2$  is made at height  $\frac{h}{2}$  from the bottom. Find the area of cross-section of stream of liquid (in  $\text{cm}^2$ ) just before it hits the ground.



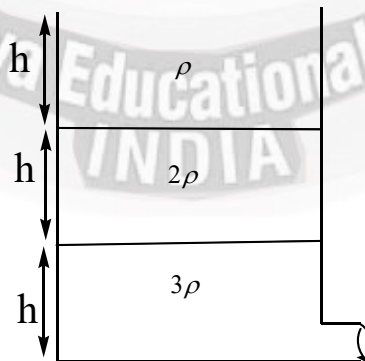
24. Liquid of density  $\rho$  is flowing through a hole of cross-sectional area  $\left(\frac{A_0}{10}\right)$ . ( $A_0 \rightarrow$  cross-sectional area of vessel). Force  $F$  which is needed to keep vessel at rest at the instant shown in diagram is  $\frac{\rho g H A_0}{N}$  then the value of  $N$  is



25. A cylindrical vessel of radius  $R=4\text{ m}$  and height  $H=30\text{ m}$  is half filled with liquid. It is rotated with angular speed  $\omega$  about the central axis as shown. The free surface of the liquid takes paraboloidal shape. The value of  $\omega$  (in rad/s) for which vertex of the parabola is at a distance  $\frac{H}{2}$  below  $P$  is ( $g = 10\text{ m/s}^2$ )



26. The speed (in m/s) of the liquid coming out of a small hole of an open large vessel containing three liquids of same height ( $h=10\text{ m}$ ) of densities  $3\rho$ ,  $2\rho$  and  $\rho$  as shown in figure, is ( $g = 10\text{ m/s}^2$ )







## SECTION – II

### (ONE OR MORE CORRECT ANSWER TYPE)

This section contains **SIX (06)** questions.

- Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated according to the following marking scheme :

**Full Marks** : +4 **ONLY** if (all) the correct option(s) is(are) chosen;

**Partial Marks** : +3 If all the four options are correct but **ONLY** three options are chosen;

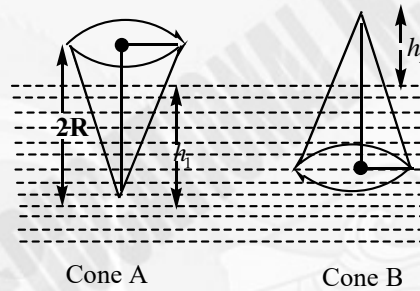
**Partial Marks** : +2 If three or more options are correct but **ONLY** two options are chosen, both of which are correct ;

**Partial Marks** : +1 If two or more options are correct but **ONLY** two options are chosen, and it is a correct option ;

**Zero Marks** : 0 If none of the options is chosen (i.e. the question is unanswered);

**Negative Marks** : -2 In all other cases.

27. Two identical solid cones of base radius  $R$  and height  $2R$  float in water as shown in figure. Cone A has height  $h_1$  immersed in Water while Cone B has height  $h_2$  lying outside the water. Relative density of each cone is  $\frac{1}{3}$ .



A) Value of  $\frac{h_1}{h_2}$  will be  $\frac{1}{2^3}$

B) Value of  $\frac{h_1}{h_2}$  will be 1

- C) If cone A is further suppressed by small distance  $x$  and released, it will execute SHM.

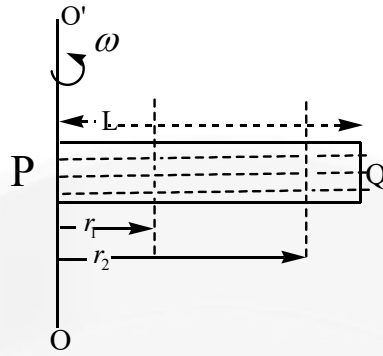
The time period of oscillation would be  $(3)^{-\frac{4}{3}} \left[ 2\pi \sqrt{\frac{2R}{g}} \right]$

- D) If cone A is further suppressed by small distance  $x$  and released, it will execute SHM.

The time period of oscillation would  $(3)^{-\frac{4}{3}} \left[ 2\pi \sqrt{\frac{R}{g}} \right]$

28. A thin cylindrical tube of length  $L$  and cross-sectional area  $A$ , filled with water ( $\rho_W$ ) and closed at both ends uniformly rotates in a horizontal plane about axis  $OO'$ . The pressure at distance  $r_1$  and  $r_2$  from the rotational axis is  $P_1$  and  $P_2$ . Then choose the correct statement  
(Neglect atmospheric pressure)





A) Pressure at point  $P$  is minimum

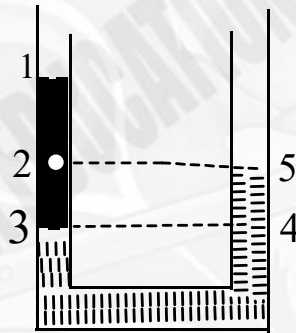
$$B) \omega = \sqrt{\frac{2(p_2 - p_1)}{\rho_w(r_2^2 - r_1^2)}}$$

C) Pressure at point  $Q$  is maximum

D) Pressure at middle of the rod is maximum

29.

A manometer contains two different fluids of different densities (figure). Both sides are open to the atmosphere. Which pair(s) of point have equal pressure?



A)  $P_1 = P_5$

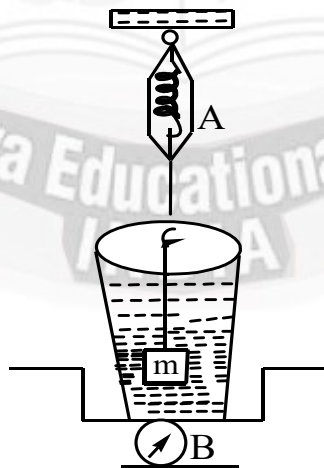
B)  $P_2 = P_5$

C)  $P_3 = P_4$

D)  $P_1 = P_3$

30.

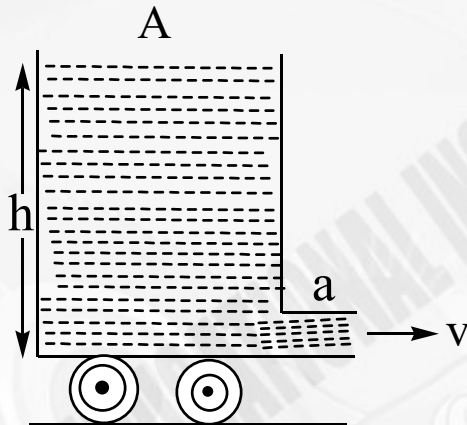
The spring balance  $A$  reads 2 kg with a block  $m$  suspended from it. A balance  $B$  reads 5kg when a beaker filled with liquid is put on the pan of the balance. The two balances are now arranged that the hanging mass is inside the liquid as shown in the figure. In this situation





- A) The balance  $A$  will read more than  $2\text{ kg}$   
 B) Sum of the reading of spring balance ' $A$ ' and balance  $B$  is  $7\text{ kg}$   
 C) The balance  $A$  will read less than  $2\text{ kg}$  and  $B$  will read more than  $5\text{ kg}$   
 D) The balance  $A$  and  $B$  will read  $2\text{ kg}$  and  $5\text{ kg}$  respectively

31. A container having a hole at the bottom is free to move on a horizontal surface. As the liquid comes out, container moves in backward direction with an acceleration  $\alpha$ . Neglect the mass of container. Select the correct option(s).



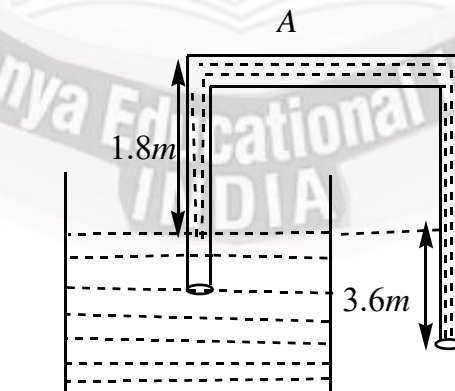
- A)  $\alpha$  is independent of height of liquid in vessel

B)  $\alpha$  is given by  $\alpha = \frac{gh}{a}$

C)  $\alpha$  is given by  $\alpha = \frac{ag}{A}$

D)  $\alpha$  is given by  $\alpha = \frac{2ag}{A}$

32. A siphon has a uniform circular cross section of diameter  $8/\sqrt{\pi}\text{ cm}$  with its crest  $A$ ,  $1.8\text{ m}$  above the water level in vessel  $B$  of large cross-section ( $g = 10\text{ m/s}^2$ , density of water is  $1000\text{ kg/m}^3$  and atmospheric pressure  $P_0 = 10^5\text{ N/m}^2$ )







- A) Velocity of flow through pipe is  $6\sqrt{2}$  m/s  
 B) Discharge rate of flow through pipe is  $96\sqrt{2} \times 10^{-4} m^3 / s$   
 C) Velocity of flow through pipe is 6 m/s  
 D) Pressure of A is  $0.46 \times 10^5 N / m^2$

**SECTION – III**  
**(MATCHING TYPE)**

This section contains **FOUR (04)** Matching List Sets.

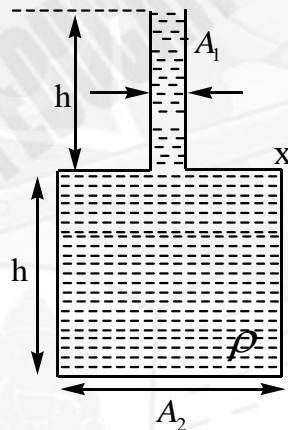
- Each set has **ONE** Multiple Choice Question.
- Each set has **TWO** lists : **List-I** and **List-II**.
- List-I** has **Four** entries (I), (II), (III) and (IV) and **List-II** has **Five** entries (P), (Q), (R), (S) and (T).
- FOUR** options are given in each Multiple Choice Question based on **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.
- Answer to each question will be evaluated according to the following marking scheme :

Full Marks: +3 **ONLY** if the option corresponding to the correct combination is chosen;

Zero Marks: 0 If none of the options is chosen (i.e. the question is unanswered);

Negative Marks: -1 In all other cases.

33. The vessel shown in the Fig. has two sections of area of cross-section  $A_1$  and  $A_2$ .  
 A liquid of density  $\rho$  fills both the sections, up to a height  $h$  in each.  
 Neglect atmospheric pressure.



	Column-I		Column-II
a)	The net force exerted by liquid on side walls is	p)	$2h\rho gA_2$
b)	The force exerted by the liquid on the base of the vessel is	q)	Zero
c)	The weight of the liquid in vessel	r)	$h\rho g(A_2 - A_1)$
d)	The walls of the vessel at the level X exert a downward force is	s)	Less than $2h\rho gA_2$

A)  $a \rightarrow p, b \rightarrow s, c \rightarrow q, d \rightarrow r$

B)  $a \rightarrow q, b \rightarrow p, c \rightarrow s, d \rightarrow r$

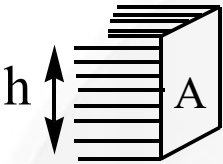
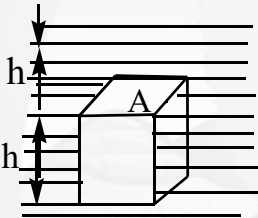
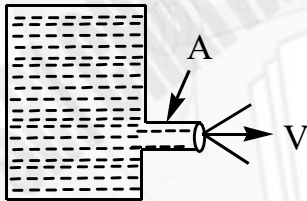

C)  $a \rightarrow s, b \rightarrow r, c \rightarrow q, d \rightarrow p$

D)  $a \rightarrow r, b \rightarrow q, c \rightarrow s, d \rightarrow p$





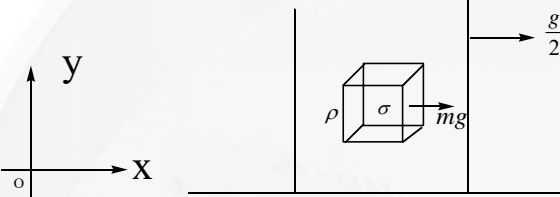
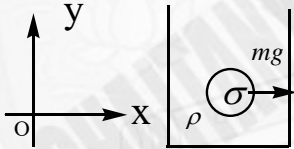
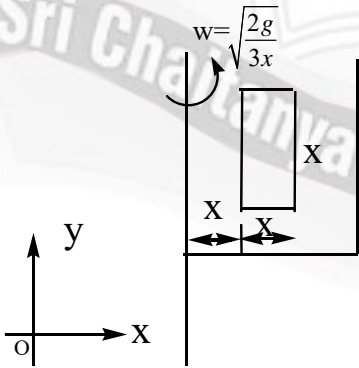
## 34. Match the Columns

	Column-I		Column-II
a)	Hydrostatic force on the side wall of the cubical vessel of area of cross section A is ( $\rho$ = density of liquid, neglect atmospheric pressure) 	p)	$A\rho v^2$
b)	Buoyant force on the cube of area of cross section A is ( $\rho$ = density of liquid) 	q)	$\frac{1}{2}A\rho v^2$
c)	Impact (reaction) force on the vessel by the liquid coming out of the vessel, ( $\rho$ = density of liquid) 	r)	$\rho ghA$
d)	Aerodynamic force acting on the flat roof surface of area A, $\rho$ = density of air (Assume speed of air above the plate is v and below the plate is 0) 	s)	$\frac{1}{2}\rho ghA$

A) a  $\rightarrow$  p, b  $\rightarrow$  s, c  $\rightarrow$  q, d  $\rightarrow$  rB) a  $\rightarrow$  q, b  $\rightarrow$  p, c  $\rightarrow$  s, d  $\rightarrow$  rC) a  $\rightarrow$  s, b  $\rightarrow$  r, c  $\rightarrow$  p, d  $\rightarrow$  qD) a  $\rightarrow$  r, b  $\rightarrow$  q, c  $\rightarrow$  s, d  $\rightarrow$  p



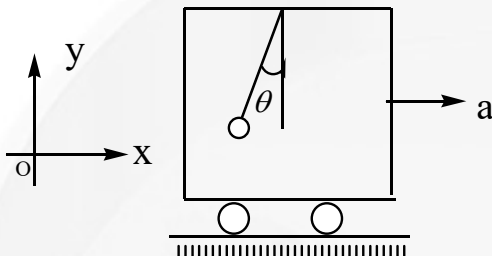
## 35. Match the following

	Column-I		Column-II
a)	<p>Cube of mass <math>m</math> and density <math>\sigma</math> is pulled by a force <math>\vec{F}_x = mg\hat{i}</math> in an accelerating liquid of density <math>\rho</math>. The value of <math>\frac{a_x}{a_y}</math> of cube is</p> 	p)	$\frac{\rho}{\sigma}$
b)	<p>The sphere of mass <math>m</math> is pulled horizontally by force <math>F_x = mg</math> in non-accelerating liquid. The value of <math>\frac{a_x}{a_y}</math> of sphere is</p> 	q)	1:1
c)	<p>A closed cube of length <math>x</math> is placed in a rotating liquid. The value of <math>a_x / g</math>, (where <math>a_x</math> is the horizontal acceleration of the cube) is</p> 	r)	$\frac{\sigma}{\rho - \sigma}$





- d) The string of a pendulum makes an angle  $\theta$  with vertical when the cart moves with an acceleration  $a$ . If the cart is filled with liquid of density  $\rho < \sigma$  (density of the bob), the value of the angle of inclination with vertical becomes  $\theta^1$  then  $\frac{\tan \theta}{\tan \theta^1}$



s)  $\frac{2\sigma + \rho}{2(\sigma - \rho)}$

A)  $a \rightarrow p, b \rightarrow s, c \rightarrow q, d \rightarrow r$

B)  $a \rightarrow q, b \rightarrow p, c \rightarrow s, d \rightarrow r$

C)  $a \rightarrow s, b \rightarrow r, c \rightarrow p, d \rightarrow q$

D)  $a \rightarrow r, b \rightarrow q, c \rightarrow s, d \rightarrow p$

36. When ice melts completely, level of liquid in which ice is submerged

	Column-I		Column-II
a)		p)	Increases
b)		q)	Decreases
c)		r)	Remains same
d)	 Density of oil is greater than density of ice	s)	May increases or decreases

A)  $a \rightarrow p, b \rightarrow s, c \rightarrow q, d \rightarrow r$

B)  $a \rightarrow q, b \rightarrow p, c \rightarrow s, d \rightarrow r$

C)  $a \rightarrow s, b \rightarrow r, c \rightarrow q, d \rightarrow p$

D)  $a \rightarrow r, b \rightarrow q, c \rightarrow r, d \rightarrow p$

**CHEMISTRY****Max Marks: 60****SECTION – I  
(NUMERICAL VALUE TYPE)**This section contains **EIGHT (08)** questions.

- The answer to each question is a **NUMERICAL VALUE**.
- For each question, enter the correct numerical value of the answer using the mouse and the on-screen virtual numeric keypad in the place designated to enter the answer. If the numerical value has more than two decimal places, **truncate/round-off** the value to **TWO** decimal places.
- Answer to each question will be evaluated according to the following marking scheme :

Full Marks: +3 **ONLY** if the correct numerical value is entered ;

Partial Mark: 0 In all other cases.

37. Reaction of 3 moles of  $BCl_3$  with 3 moles of  $NH_4Cl$  at  $140^\circ C$  produces compound  $P$  (containing boron). Further,  $P$  reacts  $NaBH_4$  to give colourless liquid  $Q$  as one of the product. If heated with water,  $Q$  hydrolyses slowly, Produces three compound  $R, S$  and  $T$ . Sum of the atomicity of  $R, S$  and  $T$  molecule is:
38. Lithium nitride hydrolyses in water to produce a basic solution. What is the mass (in grams) of  $HCl$  required to neutralize the 1 litre solution in which 3 moles of lithium nitride is dissolved:
39. The sum of coordination number of aluminium ion and the number of bridging hydrogen atoms in  $[Al(BH_4)_4]^-$  are respectively,
40. The number of isomeric structure of di-substituted methyl borazine ( $B_3N_3H_4(CH_3)_2$ ) is \_\_\_\_.
41.  $C_{60}$  Fullerene is called Buckminster fullerene that contains six-member as well as five-member rings. If a five-member ring is fused with  $X$  six-member And  $Y$  five-member rings, what is the value of  $X+Y$ ?
42. The number of moles of  $H_2$  liberated when one mole of borazole i.e inorganic benzene is formed on heating diborane with ammonia is
43. How many statements are **CORRECT**?
- In the pure state  $H_2O_2$  is almost colourless (very pale blue)
  - Magnesium is an essential constituent of chlorophyll, the green colouring Matter of plants.
  - Calcium bicarbonate is known in solid state.
  - $BeH_2$  is an interstitial hydride.
  - In the electrolysis of fused calcium hydride, hydrogen is liberated at cathode.
  - $MgCl_2 \cdot 6H_2O$  on heating forms  $MgCl_2$ .





44. How many of following are correctly matched (increasing order of indicated property)

- |                                     |                                  |
|-------------------------------------|----------------------------------|
| (i) Thermal stability               | $BeSO_4 < MgSO_4 < CaSO_4$       |
| (ii) Polarising power               | $Ca^{2+} < Mg^{2+} < Be^{2+}$    |
| (iii) Solubility in $H_2O$          | $Be(OH)_2 < Mg(OH)_2 < Ca(OH)_2$ |
| (iv) Covalent nature                | $CaCl_2 < MgCl_2 < BeCl_2$       |
| (v) Rate of Hydrolysis nature       | $CaCl_2 < MgCl_2 < BeCl_2$       |
| (vi) Magnitude of Lattice energy    | $BaF_2 < CaF_2 < MgF_2$          |
| (vii) Magnitude of Hydration energy | $Ba^{2+} < Mg^{2+} < Be^{2+}$    |

**SECTION – II**  
**(ONE OR MORE CORRECT ANSWER TYPE)**

This section contains **SIX (06)** questions.

- Each question has **FOUR** options (A), (B), (C) and (D). **ONE OR MORE THAN ONE** of these four option(s) is(are) correct answer(s).
- For each question, choose the option(s) corresponding to (all) the correct answer(s).
- Answer to each question will be evaluated according to the following marking scheme :

Full Marks : +4 **ONLY** if (all) the correct option(s) is(are) chosen;

Partial Marks: +3 If all the four options are correct but **ONLY** three options are chosen;

Partial Marks: +2 If three or more options are correct but **ONLY** two options are chosen, both of which are correct ;

Partial Marks: +1 If two or more options are correct but **ONLY** two options are chosen, and it is a correct option ;

Zero Marks : 0 If none of the options is chosen (i.e. the question is unanswered);

Negative Marks : -2 In all other cases.

45. The correct reaction(s) among the following is/are

- A)  $3B_2O_3 + P_2O_5 \rightarrow 2P(BO_2)_3 + O_2$   
 B)  $B_2O_3 + CoO \rightarrow Co(BO_2)_2$   
 C)  $H_3BO_3(s) + 4HF(aq) \rightarrow HBF_4 + 3H_2O(l)$   
 D)  $BCl_3 + 3H_2O \rightarrow H_3BO_3 + 3HCl$

46. A compound 'X' on heating gives a colourless gas which is not a supporter of Combustion. The residue is dissolved in water and excess of  $SO_2$  is passed through it.

First we get white ppt which dissolves in excess of  $SO_2$  Compound 'X' cannot be

- A)  $CaCO_3$       B)  $NaNO_3$       C)  $CaSO_4 \cdot 2H_2O$       D)  $K_2CO_3$

47. Metal  $M + air \xrightarrow{\Delta} A \xrightarrow{H_2O} B \xrightarrow{HCl}$  white dense fumes, Metal M can be:

- A) K      B) Ca      C) Mg      D) Rb

48. Structure of  $Na_2[B_4O_5(OH)_4] \cdot 8H_2O$  contains:

- A) 2 triangular and 2 tetrahedral units of boron  
 B) 3 triangular and one tetrahedral units of Boron  
 C) all tetrahedral units of boron  
 D) all triangular units of boron







49. Which of the following statements about graphite is/are correct
- A) In graphite inter layer spacing is more than C- C bond length With in the layer
- B) Graphite is chemically more reactive compared to diamond
- C) Graphite is thermodynamically more stable compared to diamond.
- D) Graphite is an aromatic in nature
50. Which of the following statements is/are correct
- A) Zeolites are alumino silicates having three dimensional Network structure
- B) Replacing one quarter of the  $Si^{+4}$  in  $SiO_2$  with  $Al^{+3}$  give a frame work ion  $AlSi_3O_8^-$
- C) Zeolites are used as cation exchangers.
- D) Zeolites behave like molecular sieves.

### SECTION – III (MATCHING TYPE)

This section contains **FOUR (04)** Matching List Sets.

- Each set has **ONE** Multiple Choice Question.
- Each set has **TWO** lists : **List-I** and **List-II**.
- List-I** has **Four** entries (I), (II), (III) and (IV) and **List-II** has **Five** entries (P), (Q), (R), (S) and (T).
- FOUR** options are given in each Multiple Choice Question based on **List-I** and **List-II** and **ONLY ONE** of these four options satisfies the condition asked in the Multiple Choice Question.
- Answer to each question will be evaluated according to the following marking scheme :

Full Marks: +3 **ONLY** if the option corresponding to the correct combination is chosen;

Zero Marks: 0 If none of the options is chosen (i.e. the question is unanswered);

Negative Marks: -1 In all other cases.

51. Match the following:

	Column (A) Reaction.		Column (B) All Product's character.
A)	$2Na_2O \xrightarrow{400^\circ C}$	P)	Diamagnetic
B)	$4LiNO_3 \xrightarrow{\Delta}$	Q)	Paramagnetic
C)	$Na + O_2(excess) \xrightarrow{350^\circ C}$	R)	Bond order 1
D)	$K \text{ (dissolved in liquid } NH_3) \rightarrow$	S)	Bond order 1.5
		T)	Blue colour solution

- A) (A → P, Q, R), (B → P, Q, S), (C → P, R), (D → Q, T)
- B) (A → P, Q, R, S), (B → P, Q, R, S), (C → P, R), (D → Q, T)
- C) (A → P, Q), (B → P, R), (C → Q, T), (D → P, R)
- D) (A → Q, R), (B → P, Q, R, S), (C → P, R), (D → T)





52. Match the matrix.

	Column-I		Column-II
A)	0.2 mole $H_3BO_3$ + 0.1 mole $NaOH_{(aq.)} \rightarrow$	P)	Resulting product contain $H_3BO_3$
B)	$Na_2B_4O_7(s) + H_2O \rightarrow solution$	Q)	Alkaline solution
C)	$K_3BO_3$ (limiting reagent) + $H_2SO_4 \rightarrow$	R)	$[B(OH)_4]^-$ in solution
D)	$B_2H_6 + H_2O_{(excess)} \rightarrow$	S)	Volatile product
		T)	Buffer solution

A) (A  $\rightarrow$  P,Q,R),(B  $\rightarrow$  Q,R,T),(C  $\rightarrow$  Q,R),(D  $\rightarrow$  T)B) (A  $\rightarrow$  P,Q,R,T),(B  $\rightarrow$  P,Q,R,T),(C  $\rightarrow$  P),(D  $\rightarrow$  P,R,S)C) (A  $\rightarrow$  P,Q,R,T),(B  $\rightarrow$  P,Q),(C  $\rightarrow$  Q),(D  $\rightarrow$  P,R,S)D) (A  $\rightarrow$  P,Q),(B  $\rightarrow$  R,T),(C  $\rightarrow$  P),(D  $\rightarrow$  T)

53. Match the following

	Column-I		Column-II
A)	$BCl_3$	P)	Central atom in $sp^2$ hybridization
B)	$H_3BO_3$	Q)	Central atom in $sp^3$ hybridization
C)	$BH_4^-$	R)	acts as Lewis acid
D)	$AlCl_3(g)$	S)	Gives white fumes with moisture

A) (A  $\rightarrow$  Q,S),(B  $\rightarrow$  Q,R),(C  $\rightarrow$  Q),(D  $\rightarrow$  P,R,S)B) (A  $\rightarrow$  Q,S),(B  $\rightarrow$  P,S),(C  $\rightarrow$  Q),(D  $\rightarrow$  P,Q,R,S)C) (A  $\rightarrow$  P,R,S),(B  $\rightarrow$  P,R),(C  $\rightarrow$  Q),(D  $\rightarrow$  P,R,S)D) (A  $\rightarrow$  P,R,S),(B  $\rightarrow$  P,R),(C  $\rightarrow$  Q,R),(D  $\rightarrow$  P,R,S)

54. Match the column

	Column-I		Column-II
A)	$Cl_2 + cold \text{ and dilute } NaOH \longrightarrow$	P)	Disproportionation take place
B)	$Cl_2 + hot \text{ and conc. } NaOH \longrightarrow$	Q)	Chloride ( $Cl^-$ ) is produced
C)	$2NaNO_3 \xrightarrow[500^\circ C]{\Delta}$	R)	Chlorate ( $ClO_3^-$ ) is produced
D)	$ClO_2 + NaOH(aq) \rightarrow$	S)	Hypochlorite ( $OCl^-$ ) is produced
		T)	Chlorite ( $ClO_2^-$ ) is produced
		U)	oxygen gas is liberated

A) (A  $\rightarrow$  P,Q,S),(B  $\rightarrow$  P,Q,R),(C  $\rightarrow$  U),(D  $\rightarrow$  P,R,T)B) (A  $\rightarrow$  P,Q,S,T,U),(B  $\rightarrow$  P,R,T),(C  $\rightarrow$  Q,U),(D  $\rightarrow$  P,R,T)C) (A  $\rightarrow$  P,Q),(B  $\rightarrow$  Q,R),(C  $\rightarrow$  U),(D  $\rightarrow$  Q,R,T)D) (A  $\rightarrow$  P,Q,S),(B  $\rightarrow$  P,Q,R),(C  $\rightarrow$  P,Q),(D  $\rightarrow$  P,R,T)





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