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Permutation:-

"An arrangement of a finite number of objects some or all at a time is called Permutation."

If n are the total objects and r objects are taken at a time, then permutation is written as

$${}^n P_r = \frac{n!}{(n-r)!} \quad \text{where } r \leq n$$

$$* {}^n P_n = \frac{n!}{(n-n)!} = n! \quad * {}^n P_0 = \frac{n!}{(n-0)!} = 1$$

Fundamental Principle of Counting:

Suppose A and B are two events. A occurs in p different ways and B occurs in q different ways.

The number of ways of occurrence of the two events are the product $p \cdot q$.

* This principle can be extended for more than two events.

Exercise: T-2

Q.1 Evaluate the followings

$$(i) {}^{20}P_3 = \frac{20!}{(20-3)!} = \frac{20!}{17!}$$

$${}^{20}P_3 = \frac{20 \cdot 19 \cdot 18 \cdot 17!}{17!} = 20 \cdot 19 \cdot 18$$

$${}^{20}P_3 = 6840 \text{ Ans.}$$

$$(ii) {}^{16}P_4 = \frac{16!}{(16-4)!}$$

$${}^{16}P_4 = \frac{16!}{12!} = \frac{16 \cdot 15 \cdot 14 \cdot 13 \cdot 12!}{12!}$$

$${}^{16}P_4 = 43680 \text{ Ans.}$$

$$(iii) {}^{12}P_5 = \frac{12!}{(12-5)!} = \frac{12!}{7!}$$

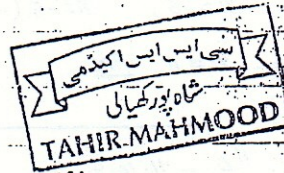
$${}^{12}P_5 = \frac{12 \cdot 11 \cdot 10 \cdot 9 \cdot 8 \cdot 7!}{7!}$$

$${}^{12}P_5 = 95040 \text{ Ans.}$$

$$(iv) {}^{10}P_7 = \frac{10!}{(10-7)!} = \frac{10!}{3!}$$

$${}^{10}P_7 = \frac{10 \cdot 9 \cdot 8 \cdot 7 \cdot 6 \cdot 5 \cdot 4 \cdot 3!}{3!}$$

$${}^{10}P_7 = 604800 \text{ Ans.}$$



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$$(v) {}^9P_8 = \frac{9!}{(9-8)!} = \frac{9!}{1!}$$

$$(vii) {}^n P_4 : {}^{n-1} P_3 = 9 : 1$$

$${}^9P_8 = 9 \cdot 8 \cdot 7 \cdot 6 \cdot 5 \cdot 4 \cdot 3 \cdot 2$$

$${}^9P_8 = 362880 \text{ Ans.}$$

$$\frac{{}^n P_4}{{}^{n-1} P_3} = \frac{9}{1}$$

$$\frac{n!}{(n-4)!} \cdot \frac{(n-1)!}{(n-1-3)!} = \frac{9}{1}$$

$$\frac{n!(n-4)!}{(n-1)!(n-4)!} = \frac{9}{1}$$

$$\frac{n(n-1)!}{(n-1)!} = \frac{9}{1}$$

$$n = 9 \text{ Ans.}$$

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Q.2 Find the value of n when:

$$(i) {}^n P_2 = 30$$

$$\frac{n!}{(n-2)!} = 30$$

$$\frac{n(n-1)(n-2)!}{(n-2)!} = 30$$

$$n^2 - n - 30 = 0$$

$$n^2 - 6n + 5n - 30 = 0$$

$$(n-6)(n+5) = 0$$

$$n-6=0 \quad \vee \quad n+5=0$$

$$n=6, \quad n=-5 \text{ (-ve so negligible)}$$

$$\Rightarrow n=6 \text{ Ans.}$$

$$(ii) {}^{11}P_n = 11 \cdot 10 \cdot 9$$

$$\frac{11!}{(11-n)!} = 11 \cdot 10 \cdot 9$$

$$\frac{11 \cdot 10 \cdot 9 \cdot 8!}{(11-n)!} = 11 \cdot 10 \cdot 9$$

$$\frac{8!}{(11-n)!} = 1$$

$$8! = (11-n)!$$

$$8 = 11-n \Rightarrow n = 11-8$$

$$n = 3 \text{ Ans.}$$

Q.3 Prove from first Principle:

$$(i) {}^n P_r = n \cdot {}^{n-1} P_{r-1}$$

$$RHS = n \cdot {}^{n-1} P_{r-1}$$

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

$$= \frac{n(n-1)!}{(n-r)!}$$

$$= \frac{n!}{(n-r)!}$$

$$= {}^n P_r \text{ (Proved)}$$

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Imp.

$$(ii) {}^n P_r = {}^{n-1} P_r + r \cdot {}^{n-1} P_{r-1}$$

$$RHS = {}^{n-1} P_r + r \cdot {}^{n-1} P_{r-1}$$

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

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

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Q.6 How many words can be formed using all the letters

(i) PLANE

No. of letters = 5

$$\begin{aligned} \text{No. of words using all letters} &= {}^5P_5 = \frac{5!}{(5-5)!} \\ &= \frac{5 \cdot 4 \cdot 3 \cdot 2 \cdot 1}{1} = 120 \quad \text{Ans.} \end{aligned}$$

(ii) OBJECT

No. of letters = 6

$$\begin{aligned} \text{No. of words using all letters} &= {}^6P_6 = \frac{6!}{(6-6)!} \\ &= \frac{6 \cdot 5 \cdot 4 \cdot 3 \cdot 2 \cdot 1}{1} = 720 \quad \text{Ans.} \end{aligned}$$

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(iii) FASTING

No. of letters = 7

$$\begin{aligned} \text{No. of words using all the letters} &= {}^7P_7 = \frac{7!}{(7-7)!} \\ &= \frac{7 \cdot 6 \cdot 5 \cdot 4 \cdot 3 \cdot 2 \cdot 1}{1} = 5040 \quad \text{Ans.} \end{aligned}$$

Q.7 How many 3-digit numbers can be form using 2,3,5,7,9 once?

No. of digits = 5

Digits forming each number = 3

$$\begin{aligned} \text{3-digit numbers} &= {}^5P_3 = \frac{5!}{(5-3)!} \\ &= \frac{5 \cdot 4 \cdot 3 \cdot 2 \cdot 1}{2!} = 5 \cdot 4 \cdot 3 \\ &= 60 \quad \text{Ans.} \end{aligned}$$

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Q.8 ^{Imp.} To find numbers greater than 23000 using 1,2,3,4,5 once.

The numbers greater than 23000 are form when

$$23000 \times = {}^3P_3 = 6$$

$$24000 \times = {}^3P_3 = 6$$

$$25000 \times = {}^3P_3 = 6$$

$$30000 \times = {}^4P_4 = 24$$

$$40000 \times = {}^4P_4 = 24$$

$$50000 \times = {}^4P_4 = 24$$

Total nos. greater than 23000 = 24+24+24+6+6+6 = 90. Ans.

Q.9 ^{Imp.} To find 5-digit numbers using 1,2,4,6,8 once.

$$\text{Total 5 digit numbers} = {}^5P_5 = 120$$

(i) The numbers when 2 and 8 are next together

$$\text{Permutation when 28 together} = {}^4P_4 = 24$$

$$\text{Permutation when 82 together} = {}^4P_4 = 24$$

Total numbers containing 2 and 8 together = 24+24 = 48. Ans.

(ii) The numbers when 2 and 8 are not next together.

$$\text{Numbers without 2,8 together} = 120 - 48 = 72 \text{ Ans.}$$

Q.10 To find 6-digit numbers using 0,1,2,3,4,5 once.

The 6-digit numbers will be form if 0 is not at the extreme

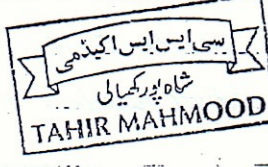
left position so five possibilities are available out of 6.

$$\text{Thus total number of 6-digits} = 5 \cdot {}^5P_5 = \frac{5 \cdot 5!}{0!}$$

$$= 5 \cdot 5 \cdot 4 \cdot 3 \cdot 2 \cdot 1 = 600 \text{ Ans.}$$

The numbers containing 0 at tens place $\times \times \times \times 0 \times = {}^5P_5$

$$\text{TAHIR} = \frac{5!}{0!} = 120 \text{ numbers. Ans.}$$



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Q.11 The 5 digit numbers using 2,3,5,7,9 once

Total 5 digit numbers = ${}^5P_5 = 120$

The numbers will be multiple of 5 if the number extreme right will be 5 so 4 digits are left and 1 is fixed

The 5 digit numbers multiple of 5 = ${}^4P_4 = \frac{4 \cdot 3 \cdot 2 \cdot 1}{1} = 24$ Ans.

Q.12 Total number of books = 8

Let E_1 and E_2 be the two English books.

Total ways of arranging 8 books = ${}^8P_8 = 40320$

Permutation containing E_1, E_2 together = ${}^7P_7 = 5040$

Permutation Containing E_2, E_1 together = ${}^7P_7 = 5040$

Total no. of ways containing E_1, E_2 together = $5040 + 5040 = 10080$

The ways without E_1, E_2 together = $40320 - 10080 = 30240$ Ans.

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Q.13 Total books = 8

Let E denotes English books and U denoted Urdu books

Permutation containing $EEEUUUUU = {}^3P_3 \cdot {}^5P_5 = 6 \times 120 = 720$

Permutation Containing $UUUUUUUU = {}^5P_5 \cdot {}^3P_3 = 120 \times 6 = 720$

Total arrangements containing books of same subject together } = $720 + 720 = 1440$ Ans.

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Q.14 Total no. of persons = 9

Permutation containing the ways of 5 boys = ${}^5P_5 = 120$

Permutation Containing the ways of 4 girls = ${}^4P_4 = 24$

Permutation Containing all the boys and girls = ${}^5P_5 \cdot {}^4P_4$

= $120 \times 24 = 2880$ Ans.