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MULTIPLICATION
1-12

1 **Q) What is Multiplication ?**
A) Multiplication is the Repeated Addition of the Same Number or Quantity.

2 **The Multiplicand is the Quantity or Number to be Multiplied.**

3 **Multiplication is an Operation in which two Numbers are Combined to give a Third Number called the Product; denoted by a x b = c , where c is the Product and (a x b), ab = c is the Instance of Multiplication.**

4 **Fractions are Multiplied by Multiplying the Numerators and Denominators Separately, such that ;**

$$a/b \times c/d = ac/bd .$$

5 **Multiplication can be regarded as the Process of Multiplying One Number, the Multiplicand, by another Number, the Multiplier. The Result is the same for whichever Number is chosen for the Multiplicand.**

6 **Polynomials are Multiplied by using the Distributive Law.**

7 **Complex Numbers can be Multiplied Similarly :**

$$(a + ib)(c + id) = ac + iad + ibc + ibd = (ac - bd) + i(ad + bc)$$

8 The Concept of Multiplication has been extended to other Entities, such as Vectors, Matrices and Sets.

9 Q) How Do We Multiply Vectors using the DOT PRODUCT ?

The dot product is found by multiplying the matching parts of the two vectors and then adding all the results together.

Step-by-Step

1. **Take the first number in the first vector and multiply it by the first number in the second vector.**
2. **Take the second number in the first vector and multiply it by the second number in the second vector.**
3. **Continue this process for all remaining numbers.**
4. **Add all the products together.**
5. **The final answer is a single ordinary number called a scalar.**

Example in Words

- **Multiply the first pair of numbers.**
- **Multiply the second pair of numbers.**
- **Multiply the third pair of numbers.**
- **Add the three answers together.**
- **The sum is the dot product.**

10 Q) How Do We Multiply Vectors using the Cross Product

The cross product creates a new vector that points in a direction perpendicular to both original vectors.

Step-by-Step

1. **Write the two vectors in order beneath the directional symbols for the x direction, y direction, and z direction.**
2. **Multiply the numbers diagonally across from one another.**
3. **Subtract the diagonal products to find each component.**
4. **Repeat the process for the x part, y part, and z part.**
5. **Change the sign of the middle component.**
6. **Write the three resulting components together as a new vector.**

Result

- **The dot product gives a number.**
- **The cross product gives a new vector.**
- **The new vector points at a right angle to both original vectors.**

11 Q) How Do We Multiply Matrices ?

A) Matrix multiplication combines rows from the first matrix with columns from the second matrix to create a new matrix.

The number of columns in the first matrix must equal the number of rows in the second matrix.

Step-by-Step Process

Step One

Choose a row from the first matrix.

Step Two

Choose a column from the second matrix.

Step Three

Multiply each number in the chosen row by the matching number in the chosen column.

Step Four

Add all the products together.

The result becomes one entry in the new matrix.

Step Five

Repeat the process for every row and every column until the entire new matrix is completed.

Example in Words

1. **Take the first row from the first matrix.**
2. **Take the first column from the second matrix.**
3. **Multiply matching numbers together.**
4. **Add the products.**
5. **Place that answer in the first position of the new matrix.**
6. **Move to the next column and repeat.**
7. **After finishing the row, move to the next row.**
8. **Continue until all positions are filled.**

- **Rows from the first matrix interact with columns from the second matrix.**

- **Matrix multiplication is based on multiplying and adding repeatedly.**
- **The result is another matrix.**

Matrix multiplication works by matching rows with columns, multiplying corresponding numbers, adding the results, and placing each sum into a new matrix position.

12 Q) How Do We Multiply Sets ?

A) The multiplication of sets usually means forming the Cartesian Product of two sets.

A Cartesian product pairs every element of the first set with every element of the second set.

The result is a new set of ordered pairs.

Step-by-Step Process

Step One

Choose one element from the first set.

Step Two

Pair that element with every element from the second set.

Step Three

Write each pair in order.

The first element in the pair must come from the first set, and the second element must come from the second set.

Step Four

Move to the next element in the first set.

Step Five

Repeat the pairing process until every element from the first set has been paired with every element from the second set.

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1. **Start with the first element of the first set.**
2. **Pair it with the first element of the second set.**
3. **Pair it with the second element of the second set.**
4. **Continue until it has been paired with all elements of the second set.**
5. **Move to the next element of the first set.**
6. **Repeat the process.**
7. **The collection of all ordered pairs forms the product set.**

- **Every element of the first set combines with every element of the second set.**
- **Order matters in the pairs.**
- **The result is a set of ordered pairs, not ordinary multiplication.**

The multiplication of sets is performed by pairing each element of one set with every element of another set, creating a complete collection of ordered pairs called the Cartesian product.