PristinEDU

Mathematics | Modular Arithmetic: Multiplication, Division & Binary Operations

Preparing students for WAEC • NECO • JAMB/UTME

Modular Arithmetic: Multiplication, Division & Binary Operations (⊕, ⊗)

This exercise set covers solving equations that involve multiplication and division within a given modulus, and evaluating binary operations defined by symbols such as ⊕ and ⊗ using Cayley (operation) tables. Work through Section A first, then complete the tables in Section B before attempting the questions that follow each one. **Perfect for students preparing for WAEC, NECO, and JAMB Mathematics.**

Section A — Solving Multiplication & Division Equations in Modular Arithmetic

1. $4x \equiv 2 \pmod{7}$

2. $6x \equiv 3 \pmod{9}$

3. $11 \div 3 \pmod{7}$

4. $9 \div 2 \pmod{7}$

5. $5x \equiv 4 \pmod{6}$

6. $13 \div 4 \pmod{7}$

7. $7x \equiv 3 \pmod{10}$

Section B — Binary Operations & Cayley Tables (mod 5)

1. Copy and complete the tables for addition (⊕) and multiplication (⊗) in mod 5, on the set {1, 2, 3, 4}.

Addition table (⊕)

⊕	1	2	3	4
1	2		4	
2	3	4		1
3	4			2
4	0	1	2	

Multiplication table (⊗)

⊗	1	2	3	4
1	1			4
2		4		3

3	3		4	
4	4		2	1

(a) Using the tables, evaluate (3 ⊗ 3) ⊕ (2 ⊗ 2).

(b) Find m, such that m ⊗ m = m ⊕ m.

2. Copy and complete the addition (⊕) and multiplication (⊗) tables mod 5, on the set {2, 3, 4}.

Addition table (⊕)

⊕	2	3	4
2			
3			
4			

Multiplication table (⊗)

⊗	2	3	4
2			
3			
4			

(b) Use the tables to solve the equation 4 ⊗ e ⊕ 2 ≡ 1 (mod 5).

(c) Find n if 4 ⊕ (n ⊗ 2) ≡ 3 (mod 5).

3. Copy and complete the multiplication table for modulo 5 on the set {1, 2, 3, 4} below.

⊗	1	2	3	4
1	1			
2		4	1	
3	3			2
4		3		1

From the table:

(a) Solve the expression 2n ⊗ 4 = 3.

(b) Find the value of n for which 2 ⊗ (3 ⊗ n) = 2.

4. Copy and complete the subtraction table (■) for modulo 5 on the set {1, 2, 3, 4}, where a ■ b means (a – b) mod 5.

⊖	1	2	3	4
1	0		3	2

2	1	0		3
3		1	0	
4	3		1	0

(a) Using the table, evaluate (3 ■ 1) ⊕ (2 ■ 4).

(b) Solve for x: x ■ 3 ≡ 1 (mod 5).

Note: results of 0 correspond to the modulus itself (5) where relevant.

ANSWERS

Section A

1. x = 4
2. x = 2, 5, 8
3. x = 6
4. x = 1
5. x = 2
6. x = 5
7. x = 9

Section B

1. Completed tables:

Addition (⊕)

⊕	1	2	3	4
1	2	3	4	0
2	3	4	0	1
3	4	0	1	2
4	0	1	2	3

Multiplication (⊗)

⊗	1	2	3	4
1	1	2	3	4
2	2	4	1	3
3	3	1	4	2

4	4	3	2	1

(a) (3 ⊗ 3) ⊕ (2 ⊗ 2) = 4 ⊕ 4 = 3

(b) m = 2

2. Tables mirror the mod 5 operations restricted to {2, 3, 4} (values may fall outside this set, e.g. 0 or 1, since the table is still worked mod 5).

(b) 4e + 2 ≡ 1 (mod 5) ⇒ 4e ≡ 4 (mod 5) ⇒ e = 1

(c) 4 + 2n ≡ 3 (mod 5) ⇒ 2n ≡ 4 (mod 5) ⇒ n = 2

3. Completed table:

⊗	1	2	3	4
1	1	2	3	4
2	2	4	1	3
3	3	1	4	2
4	4	3	2	1

(a) 8n ≡ 3 (mod 5) ⇒ 3n ≡ 3 (mod 5) ⇒ n = 1

(b) 3 ⊗ n = 1 ⇒ n = 2

4. Completed table:

⊖	1	2	3	4
1	0	4	3	2
2	1	0	4	3
3	2	1	0	4
4	3	2	1	0

(a) (3 ■ 1) ⊕ (2 ■ 4) = 2 ⊕ 3 = 0

(b) x ≡ 4 (mod 5) ⇒ x = 4